SHOUT
SHARE
IT

506.54
B72
SI

JOURNAL

OF THE

BOMBAY NATURAL HISTORY SOCIETY

EDITED BY
SÁLIM ALI & H. SANTAPAU

VOL. 54

Nos. 1, 2, 3 and 4

Containing 9 graphs, 3 coloured and 59 black-and-white plates, 8 photographs in text, 7 maps, and 229 text-figures

---

Dates of Publication

Part 1,	**(pages 1 to 250)**	... ...	**20-12-1956**
Part 2,	**(pages 251 to 490)**	... ...	**3-6-1957**
Part 3,	**(pages 491 to 810)**	... ...	**14-10-1957**
Part 4,	**(pages 811 to 994)**	... ...	**24-12-1957**

Agents in England
**WHELDON AND WESLEY LTD.,
Lytton Lodge, Codicote, Nr. Hitchin,
Herts, England**

PRINTED AT LEADERS PRESS PVT. LTD., BOMBAY
1972

CONTENTS OF VOLUME 54

No. 1

PAGE

THE MANAGEMENT OF INDIA'S WILD LIFE SANCTUARIES AND NATIONAL PARKS, PART III. By E. P. Gee, M.A., C.M.Z.S. (*With one coloured and five black and white plates*)...... 1

NOTES ON SOME WASPS AND BEES (HYMENOPTERA) OF POONA AND THE WESTERN GHATS. By F. L. Wain, S.S.J.E. (*With a plate and* 21 *figures*) 22

DUCKS UNLIMITED: AND WILD LIFE PRESERVATION IN CEYLON. By Philip K. Crowe. (*With a plate*) 37

CHAPTERS ON THE HISTORY OF BOTANY IN INDIA. II. THE ADVANCES, AND IN PARTICULAR THE PLANT COLLECTING, OF THE THIRTIES AND FORTIES OF THE 19TH CENTURY. By I. H. Burkill 42

MARINE NEMATODES FROM THE BAY OF BENGAL. I. PHASMIDEA. By Richard W. Timm. (*With a plate*) 87

VEGETATION OF PILANI AND ITS NEIGHBOURHOOD. By N. C. Nair and G. S. Nathawat... 91

DIFFERENTIAL RESPONSE TO FORM AND PATTERN IN TWO SPECIES OF INDIAN HONEYBEES. By K. K. Dixit, M.SC. (*With two text figures*) 107

BIONOMICS OF THE PUMPKIN CATERPILLAR—*Margaronia indica* Saund. (PYRALIDAE: LEPIDOPTERA). By R. C. Patel, M.SC. and H. L. Kulkarny, M.SC. (*With a plate and a graph*) 118

THE BIOLOGY OF SCORPIONS. By Max Vachon. (*With a plate and* 17 *figures*) 128

SOME USEFUL WEEDS IN AND AROUND CUTTACK. By H. Pattnaik 140

NOTES ON THE HETEROCERA OF CALCUTTA, PART III. By D. G. Sevastopulo, F.R.E.S. 153

SOME BENEFICIAL COCCINELLIDS OF MYSORE. By M. Puttarudriah and G. P. Channa Basavanna 156

FURTHER OBSERVATIONS ON THE BIOLOGY OF THE COMMON 'TREE HOPPER' *Otinotus oneratus* WALK. (HOMOPTERA, MEMBRACIDEA) IN ORISSA. By Upendra Chandra Panda and Basanta Kumar Behura 160

REVIEWS:—

1. Powai the Angling Paradise (F.R.G.) 164
2. The Tigers of Trengganu (B. Basu) 164
3. Pelican in the Wilderness (R. R.) 166
4. The Flamingos: Their Life History and Survival (S.A.) 167
5. Embryology of *Heterometrus scaber* (M. L. Roonwal) 169
6. The early Embryology of *Pyrilla perpusilla* Walker (Homoptera) (P.J.D.) 170

PAGE

MISCELLANEOUS NOTES:—

1. Macaque Monkey eating Mushrooms. By M. L. Roonwal (p. 171). 2. Lion *v.* Tiger. By E. P. Gee (p. 171). 3. Transferring of the Indian Lion to an additional Locality. By K. S. Lavkumar (p. 173). 4. Wild Elephants in the Union of Burma. By Tun Yin (p. 175). 5. A large pair of Elephant's Tusks from Burma (*With a photo*). By Tun Yin (p. 178). 6. Albino Elephants. By Tun Yin (p. 179). 7. Predator and Prey at Salt-licks. By E. P. Gee (p. 181). 8. Incubation Period and 'Mortality Rate' (?) in a Brood of the Magpie Robin [*Copsychus saularis* (Linn.)]. By N. G. Pillai (p. 182). 9. Some Notes on the Plumages of *Centropus sinensis* (Stephens). By Humayun Abdulali (p. 183). 10. The Occurrence of the Pinkbreasted Parakeet (*Psittacula alexandri*) in Dehra Dun. By K. S. Lavkumar (p. 185). 11. Experiences with Little Ringed-Plover (*With a plate*). By Loke Wan-Tho (p. 185). 12. The Dimorphic Egrets. By J. Berlioz (p. 188). 13. Bird Notes from Kutch. By K. S. Lavkumar (p. 190). 14. Fighting among Birds. By R. S. P. Bates (p. 191). 15. Bird Migration in India. By Editors (p. 193). 16. The Changing Scene: Paucity of Bird Life in Jabalpur (M.P.). By P. V. Beatty (p. 194). 17. Solar Eclipse and Animal Behaviour. By G. H. Marsden (p. 194). 18. Jumping Snakes. By H. A. N. Medd (p. 195). 19. A Python's Meal (*With a photo*). By Tun Yin (p. 196). 20. Dhaman or Rat Snake (*Ptyas mucosus*) drinking Milk. By J. E. C. Turner (p. 196). 21. Strange Accident to a Frog (*Rana breviceps* Schneid.) By Humayun Abdulali (p. 197). 22. The Spawning of Carps. By J. D. Lovatt (p. 197). 23. On the Occurrence of Mummified Eels in the internal organs of *Polydactylus indicus* (Shaw) and *Pomadasys* sp. By K. H. Mohamed. (p. 199); 24. Occurrence of the Echiuroid Worm *Ikedella misakiensis* (Ikeda) in Indian Waters (Gulf of Kutch). (*With a text figure*). By P. W. Gideon, P. K. B. Menon, S. R. V. Rao and K. V. Jose (p. 201). 25. The unusual resistance to starvation of *Saccharicoccus sacchari* (Ckll.). By D. V. Murthy (p. 202). 26. Some interesting Observations on the Royal Chamber in the Mound of the Termite *Odontotermes redemanni* (Wasmann). By B. Banerjee (p. 203). 27. Some common Termites of Calcutta. By Barundeb Banerjee (p. 204). 28. Notes on the Common Black Garden Beetle *Basilianus neelgherriensis*. By (Miss) M. E. Wolfe Murray (p. 206). 29. *Tarache nitidula* F., a Semilooper Pest on Cotton in South India (*With a plate*). By S. Venugopal (p. 207). 30. Partial Emergence of the Imagines of Dragonflies (Odonata) due to the absence of a holding place (*With two figures*). By D. R. Krishnan (p. 210). 31. Hesperiidae of the Khasi and Jaintia Hills. By Sir Keith Cantlie (p. 212). 32. Further Notes and additions to the List of Butterflies from Bombay and Salsette. By A.E.G. Best (p. 215). 33. On the phenomenon of Drumming in Egg-laying Female Butterflies. By Vidyadhar G. Vaidya (p. 216). 34. The Poisonous Qualities of *Calotropis gigantea* R. Br. By H. Santapau (p. 218). 35. *Parthenium hysterophorus* Linn., a new record for India (*With a plate*). By R. Seshagiri Rao (p. 218). 36. Notes on *Aerides maculosum* Lindl. (*With a text figure*). By H. Santapau and Z. Kapadia (p. 220). 37. Some New Plants for the Dangs Forest, Bombay State (*With two plates*). By H. Santapau and D. P. Panthaki (p. 221). 38. China's Book-like Rock Formation with 25-million-year old Plant Fossils. By Prof. Hsen Hsu Hu (p. 225). 36. Wild Life Preservation in India. By Tolaram K. Mirchandani (p. 226).

GLEANINGS 228

NOTES AND NEWS 234

ANNUAL REPORT OF THE BOMBAY NATURAL HISTORY SOCIETY FOR THE YEAR ENDING 31ST DECEMBER 1955 235

THE HONORARY SECRETARY'S REPORT FOR THE YEAR 1955 236

APPENDIX TO THE HONORARY SECRETARY'S REPORT COVERING THE PERIOD JANUARY TO AUGUST 1956 243

MINUTES OF THE ANNUAL GENERAL MEETING 245

CORRECTIONS 245

STATEMENT OF ACCOUNTS OF THE BOMBAY NATURAL HISTORY SOCIETY 246

No. 2

PAGE

HISTORY OF OUR KNOWLEDGE OF THE INDIAN FAUNA THROUGH THE AGES. By H. Srinivasa Rao, M.A., D.SC., F.N.I. (*With two plates*) 251

VEGETATION OF HARSH NATH, ARAVALLI HILLS. By N. C. Nair and G. S. Nathawat. (*With a map*) 281

NOTES ON THE HETEROCERA OF CALCUTTA, PART IV. By D. G. Sevastopulo, F.R.E.S....... 302

VOICE AND LARYNX IN AFRICAN AND ASIATIC COLOBIDAE. By W. C. Osman Hill, M.D., F.R.S.E., and A. H. Booth. (*With two text figures*) 309

ON A ZOOLOGICAL COLLECTING TOUR OF THE ISLANDS OFF JAFFNA. By P. H. D. H. De Silva. (*With a map*) 322

FURTHER OBSERVATIONS ON THE FAMILY LIFE OF THE FIVE-STRIPED SQUIRREL, *Funambulus pennanti* WR. By (Mrs.) Aruna Banerji 335

THE SHIPWORMS OF SOUTH INDIA WITH A NOTE ON THE BREEDING SEASON OF *Bankia indica* Nair. By N. Balakrishnan Nair, Ph.D. (*With a plate, three text figures and a graph*)... 344

THE ABOMINABLE SNOWMAN, By Swami Pranavananda, F.R.G.S. 358

A BOTANICAL TRIP TO THE VALLEY OF FLOWERS. By B. N. Ghildyal. (*With a sketch map*) 365

SOME OBSERVATIONS ON THE HABITS OF THE SLENDER LORIS *Loris tardigradus* (LINNAEUS). By (Mrs.) Swarna Subramoniam, M.SC. (*With five plates*) 387

ON THE MARINE CRABS (DECAPODA: BRACHYURA) OF BOMBAY STATE, PART I. By B. F. Chhapgar, M.SC. (*With one coloured and eleven line plates, and two text figures*) 399

OBITUARY:—

Brigadier W. H. Evans, C.S.I., C.I.E., D.S.O., R.E. 440

REVIEWS:—

1. Features of Evolution in the Flowering Plants (P.V. Bole)........ 442
2. The Sherpa and the Snowman (H.A.) 443
3. Birds of Ceylon. 3. (S. A.) 444
4. An Introduction to the Botany of Tropical Crops (J. A. Ali) 444
5. Open Air Guides—Bark (H. Santapau) 445
6. List of Indian Fungi—1952-1956 (H. Santapau)........ 446
7. Butterflies of the Indian Region (T. N.) 447

MISCELLANEOUS NOTES:—

1. Footprints of 'Snowman'. By Swami Pranavananda (p. 448). 2. Hairless Lion Cubs in the Trichur Zoo. By M. Govindankutty Menon (*With a plate*) (p. 450). 3. 'Scent Trails' and 'Pooking' in Tiger. By Capt. K. Boswell (p. 452). 4. Following up wounded Tiger at night. By Capt. K. Boswell (p. 454). 5. Further notes on the Himalayan Mouse-hare, or Pika (*Ochotona rufescens*). By S. A. Akhtar (p. 455). 6. A note on Insects consumed as food by Squirrels and Birds at Kundri Forest, Palamau District, Bihar. By S. Krishnaswami and N. S. Chowhan (p. 457). 7. Tusks of Indian Elephants. By R. C. Morris (p. 460). 8. Hypnotic Behaviour of a Whiteheaded Babbler (*Turdoides striatus*). By K. K. Neelakantan (p. 460). 9. Drumming of the Malabar Goldenbacked Woodpecker *Brachypternus benghalensis*. By B. Vijayaraghavan (p. 461). 10. Accidental

PAGE

death of a Crimsonbreasted Barbet [*Megalaima haemacephala* (Müller)]. By B. Vijayaraghavan (p. 462). 11. *Halcyon pileata* inland. By F. N. Betts (p. 462). 12. Redlegged Falconet, *Erythropus amurensis* (Radde), near Bombay. By Sálim Ali (p. 463). 13. An incubating Peacock (*Pavo cristatus* Linn.). By Y. S. Shivrajkumar (p. 464). 14. Occurrence of the Ruff and Reeve [*Philomachus pugnax* (Linnaeus)] near Coimbatore. By Editors (p. 464). 15. Rednecked Phalarope (*Lobipes lobatus* Linn.) in Bhavnagar, Bombay State. By Shivrajkumar of Jasdan and R. S. Dharmakumarsinhji (*With a plate*) (p. 465). 16. Some Riddles of Game-bird Migration in Kutch. By H. H. Madansinhji of Kutch (p. 466). 17. The Liver Fluke of the Frog, *Rana tigrina*—a new record of *Mehraorchis ranarun* Srivastava, 1934 (Pleurogenitinae). By R. S. Tandon (p. 468). 18. Ticks from Baluchistan, West Pakistan. By Henry Field (p. 469). 19. Bionomics of the Pumpkin Caterpillar, *Margaronia indica* Saund. By D. G. Sevastopulo (p. 470). 20. A new pest of Screwpine in Kerala: *Agonia fuscipes* Baly (Hispinae, Chrysomelidae). By M. R. G. K. Nair (*With four figures*) (p. 470). 21. A giant form of *Celosia argentea* L. By J. Sakharam Rao (*With a photo*) (p. 474). 22. *Eclipta prostrata*, *E. erecta*, or *E. alba:* Which is the correct name ? By H. Santapau (p. 475). 23. *Alternanthera paronychioides* St. Hil.—A Correction. By H. Santapau (p. 476). 24. *Habenaria panchganiensis*—New name for a Bombay Orchid. By H. Santapau and Z. Kapadia (p. 478). 25. Wild Life Preservation in India: Predator Control and the Introduction of Exotic Species, By C. L. Boyle (p. 478).

GLEANINGS 482

NOTES AND NEWS 488

CORRECTION 489

No. 3

PAGE

FURTHER NOTES ON THE BAYA WEAVER BIRD, *Ploceus philippinus* LINN. By Sálim Ali and Vijaykumar C. Ambedkar. (*With a plate*) 491

ON THE MARINE CRABS (DECAPODA: BRACHYURA) OF BOMBAY STATE, PART II. By B. F. Chhapgar, M.SC. (*With one coloured and five line plates, and one text figure*) 503

INDIAN MARSILEAS: THEIR MORPHOLOGY AND SYSTEMATICS. By K. M. Gupta and T. N. Bhardwaja. (*With* 48 *text figures*) 550

THE LION OF THE GIR. By Lt.-Col. A. H. Mosse (Deceased) 568

NOTES ON THE *Brüelia* GROUP OF MALLOPHAGA (FEATHER-LICE), WITH DESCRIPTIONS OF FOUR NEW SPECIES. By Wolfdietrich Eichler, D.SC. (*With four text figures*) 577

BRIEF NOTES ON CROP PESTS AND THEIR CONTROL IN THE PANJAB (INDIA). By K. N. Trehan, M.SC., PH.D. (London), F.E.S.I. (*With* 34 *text figures*) 581

NOTES ON THE BIRDS OF A SELECTED AREA OF DEHRA DUN—JUNE 1946 TO JULY 1951. By Mrs. M. D. Wright (Deceased). (*With a sketch map*) 627

TIMBER BORING MOLLUSCS OF THE INDIAN COAST. 1. REPORT ON A COLLECTION FROM TONDI AND ADIRAMPATNAM, EAST COAST. By N. Balakrishnan Nair and O. N. Gurumani. (*With eight text figures*) 663

GRASS FLORA OF COIMBATORE DISTRICT (SOUTH INDIA) WITH SPECIAL REFERENCE TO FODDER GRASSES. By J. Sakharam Rao 674

ON THE MARINE FAUNA OF GULF OF KUTCH: A PRELIMINARY SURVEY. By P. W. Gideon, P. K. B. Menon, S. R. V. Rao and K. V. Jose. (*With a map, one plate and five text figures*) 690

THE GENUS *Cuscuta* IN BOMBAY. By H. Santapau, S.J., and (Miss) V. Patel, B.SC. (*With a plate*) 707

OPERATION OF THE *Dol* NET OFF THE SAURASHTRA COAST. By S. V. Gokhale. (*With seven text figures*) 714

PAGE

NOTES ON SPECIFIC IDENTIFICATION IN THE TAWNY PIPIT (*Anthus campestris*), BLYTH'S PIPIT (*A. godlewskii*), AND RICHARD'S PIPIT (*A. novaeseelandiae*) IN ASIA. By B. P. Hall. (*With a text figure*) 726

A SYSTEMATIC ACCOUNT OF THE EELS OF BOMBAY. By D. V. Bal and K. H. Mohmed. (*With fourteen text figures*) 732

THE BIOLOGY AND BIONOMICS OF *Lestodryinus pyrillae* KIEFF. (DRYINIDAE: HYMENOPTERA) A NYMPHAL PARASITE OF *Pyrilla perpusilla* Walk., AND A NOTE ON ITS ROLE IN THE CONTROL OF *Pyrilla*. By B. R. Subba Rao. (*With a plate*) 741

REVIEWS:—

1. Animals of the Ruhuna National Park (H. A.) 750
2. Living with Birds (D. E. R.) 750
3. Audubon Western Bird Guide: Land, Water and Game Birds (D. E. R.) 751
4. The Amphibia of Ceylon (E. G. S.) 752
5. British Trees: A Guide for Everyman (D. E. R.) 753
6. No Passport to Tibet (R. E. H.) 754
7. Natural History of Birds: A Guide to Ornithology (S. A.) 756
8. The Ornithologists' Guide: Especially for Overseas (S. A.) 757
9. On the Trail of Vanishing Birds (D. E. R.) 758

ADDITIONS TO THE SOCIETY'S LIBRARY 759

MISCELLANEOUS NOTES:—

1. The Abominable Snowman. By D. E. Reuben (p. 762). 2. On the status of the Great Indian Rhinoceros (*R. unicornis*) in Nepal (*With a map*). By P. D. Stracey (p. 763). 3. The Spiny Babbler in Kathmandu Valley. By R. L. Fleming (p. 766). 4. 'A Dabchick is Born'. By Lt.-Col. R. W. Burton (p. 767). 5. Bird Life of Madhya Pradesh. By H. G. Alexander (p. 768). 6. Reflected glow from the eyes of the Gharial [*Gavialus gangeticus* (Gmelin)]. By Humayun Abdulali (p. 769). 7. Occurrence of a rare Sting Ray [*Taeniura melanospila* (Bleeker)] in Bombay Waters (*With one plate and one text figure*). By H. G. Kewalramani and B. F. Chhapgar (p. 770). 8. The 'Marala'—a sink net used in the backwaters of Ganjam, Orissa (*With two text figures*). By P. Mohapatra (p. 773). 9. Migration of Insects. By Editors (p. 775). 10. Notes on the Butterflies of Rangoon. By A. E. G. Best (p. 776). 11. An episode from the life history of the Moth *Suana concolor* Walker. By S. Szafranski (p. 784). 12. Notes on the biology and control of the Lily Moth *Brithys crini* Fabricius (*With a plate*). By Nawab H. Khan and Zille Hasan Abedi (p. 785). 13. An undescribed luminous Beetle Larva from South India (*With one photograph*). By J. Samuel Raj (p. 788). 14. Two new species of *Priochirus* (Staphylinidae: Coleoptera) from India (*With two text figures*). By Rudolf Dvorak (p. 790). 15. The Swarming Termites of Delhi. By H. S. Vishnoi (p. 792). 16. On the Harpacticoid Copepod *Phyllognathopus viguieri* (Maupas) (*With one plate*). By S. Krishnaswamy (p. 793). 17. A note on the Nematode *Mermis indica* v. Linstow parasitising insects. By O. S. Bindra and S. U. Kittur (p. 796). 18. A new variety of *Gymnosporia falconeri* Lawson from northern Oudh, Uttar Pradesh. By M. B. Raizada (p. 796). 19. *Dolichos bracteatus* Baker: Clarification of nomenclature. By S. I. Ali (p. 797). 20. *Ipomoea tropica,* new name for a common Bombay plant. By H. Santapau, S.J., and V. Patel (p. 798). 21. A new species of *Gleadovia* Gamble et Prain from Manipur (*With a plate*). By D. B. Deb (p. 799). 22. *Bougainvillea buttiana* Holttum et Standley, and its cultivars in Lalbagh, Bangalore (*With a text figure*). By M. H. Mari Gowda (p. 801). 23. Some name changes in the Flora of India. By J. K. Maheshwari (p. 804)

GLEANINGS 806

NOTES AND NEWS 809

No. 4

PAGE

THE BLACKFACED WEAVER BIRD OR DIOCH IN WEST AFRICA: An Ecological Study. By Gérard Morel, Marie-Yvonne Morel and François Bourlière. (*With four plates, one text figure and three graphs*) 811

BIONOMICS OF FORAGE FISHES: OBSERVATIONS ON THE FECUNDITY OF THREE COMMON SPECIES OF MINOR BARBELS. By K. H. Ibrahim. (*With one figure*) 826

OBSERVATIONS ON THE FLORA OF KODAIKANAL. By J. Pallithanam, S.J. 835

A CONTRIBUTION TO OUR KNOWLEDGE OF THE DIATOM GENUS *Pinnularia*. By H. P. Gandhi. (*With twenty-one figures*) 845

MATING IN SCORPIONS. By A. P. Mathew. (*With three text figures*) 853

THE GENUS *Eremopogon* STAPF AND ITS AFFINITIES WITH *Schizachyrium* NEES. By M. B. Raizada and S. K. Jain. (*With a plate*) 858

INFLUENCE OF STAGE OF TIDE ON THE ATTACHMENT OF BARNACLE CYPRIDS. By A. Daniel. (*With three graphs*) 866

REPTILIANA. By Lieut.-Col. A. H. E. Mosse 869

BOTANICAL EXPLORATIONS IN THE BHILLANGNA VALLEY OF THE ERSTWHILE TEHRI GARHWAL STATE—II. By Raj Kumar Gupta 878

STUDIES ON NON-INSECT ENEMIES OF LAC, WITH SPECIAL REFERENCE TO SQUIRRELS AND BIRDS AS SERIOUS SEASONAL PREDATORS. By S. Krishnaswami, N. S. Chauhan and P. S. Negi. (*With a text figure*) 887

THE ALGAL FLORA OF THE PONDS AND PUDDLES INSIDE THE BANARAS HINDU UNIVERSITY GROUNDS, INDIA. By G. S. Venkataraman. (*With seventeen text figures*) 908

TERNS OF THE SEYCHELLES ISLANDS. By M. W. Ridley. (*With two plates*) 920

NEW PLANT RECORDS FOR SOUTH INDIA—II. By D. Daniel Sundararaj and V. Ramakrishnan. (*With two plates*) 925

OBITUARY:—

1. Norman Boyd Kinnear, 1882-1957. (*With a photo*) 928

2. Philip McDonell Sanderson, 1884-1957. (*With a photo*) 930

REVIEWS:—

1. The Evolution of Man (K.K.T.) 933

2. Pharmacognosy of Ayurvedic Drugs (Kerala) Series No. 3 (B.C.M.) 936

3. Zoological Photography in Practice (W.-T.L.) 937

ADDITIONS TO THE SOCIETY'S LIBRARY 939

PAGE

MISCELLANEOUS NOTES:—

1. The Indian Mongoose in Jamaica. By D. E. Reuben (p. 941). 2. Habits of the Serow [*Capricornis sumatraensis* (Bechstein)]. By Major R. J. Solomon (p. 941). 3. Ceylon's Wilpattu National Park (*With a plate*). By J. H. Burnett (p. 942). 4. A Sunbird's unusual nesting site (*With a photo*). By Joseph George (p. 943). 5. Edible-nest Swiftlets in Burma. By Sálim Ali (p. 944). 6. The Grey Junglefowl in Salsette. By Humayun Abdulali (p. 946). 7. Rednecked Phalarope *Lobipes lobatus* (Linnaeus) in Southeast Asia. By Tom Harrison (p.947). 8. A double-headed Krait, *Bungarus caeruleus* (Schneider) (*With a photo*). By V. R. Jha and P. D. Gupta (p. 947). 9. A jumping Snake. By J. H. H. Peppe (p. 948). 10. Additions to the Fish Fauna of the Chilka Lake (*With a text map*). By J. C. Roy and N. Sahoo (p. 949). 11. An indigenous fishing Rod and Tackle (*With a text figure*). By F. R. Goldschmidt (p. 953). 12. On a new caterpillar Pest of Screw-pine: *Lycaugesia longipalpis* Swinh. (Lepidoptera: Agrotidae) (*With a text figure*). By M. R. G. K. Nair (p. 954). 13. Egg-laying of the Dragonfly *Indophaea cardinalis* (Fraser) [Odonata: Insecta]. By (Miss) Evelyn Bowden (p. 957). 14. Note on a Hunting Wasp, *Notogonia jaculatrix* (Smith). By F. L. Wain (p. 957). 15. Notes on three common Tree-hoppers (Membracidae: Hemiptera) in Orissa. By Upendra Chandra Panda and Basanta Kumar Behura (p. 958). 16. Homeric battles on the dinner table. By Lt.-Col. R. W. Burton (p. 961). 17. Occurrence of *Apus* (Crustacea: Notostraca) in Pilani, Rajasthan. By S. N. Mathur and Narsingh Sidhu (p. 961). 18. Destruction of timber by Marine Organisms in the Karwar port (*With a graph*). By V. C. Palekar and D. V. Bal (p. 962). 19. *Solanum esuriale* Lindl. A new record for Bombay State. By V. D. Vartak (p. 965). 20. Further notes on the Indian species of *Curcuma* (Zingiberaceae). By H. Santapau (p. 966). 21. The species of *Lagenandra* of Bombay and Madras. By H. Santapau (p. 967). 22. *Neuracanthus sphaerostachyus* Dalz.—Further comments. By G. L. Shah and H. Santapau (p. 969). 23. On the occurrence of *Fritschiella tuberosa* Iyeng. in Pilani (Rajasthan) (*With a text figure*). By M. C. Joshi (p. 970). 24. A caterpillar-parasitising Fungus. By Editors (p. 973).

GLEANINGS 975

NOTES AND NEWS 976

ANNUAL REPORT OF THE BOMBAY NATURAL HISTORY SOCIETY FOR THE YEAR ENDING 31st DECEMBER, 1956 977

THE HONORARY SECRETARY'S REPORT FOR THE YEAR 1956 978

APPENDIX TO THE HONORARY SECRETARY'S REPORT COVERING THE PERIOD JANUARY TO AUGUST, 1957 985

STATEMENT OF ACCOUNTS OF THE BOMBAY NATURAL HISTORY SOCIETY 989

MINUTES OF THE ANNUAL GENERAL MEETING 994

ALPHABETICAL LIST OF CONTRIBUTORS

PAGE

Abdulali, Humayun, Some notes on the plumages of *Centropus sinensis* (Stephens) 183
————————, Strange accident to a Frog (*Rana breviceps* Schneid.)... 197
————————, Reflected glow from the eyes of the Gharial [*Gavialus gangeticus* (Gmelin)] 769
————————, The grey Junglefowl in Salsette 946
Abedi, Zille Hasan, *see* Khan, Nawab H.
Akhtar, S. A., Further notes on the Himalayan Mouse-hare or Pika (*Ochotona rufescens*) 455
Alexander, H. G., Bird life of Madhya Pradesh 768
Ali, Salim, Redlegged Falconet, *Erythropus amurensis* (Radde) near Bombay 463
————, Edible-nest Swiftlets in Burma 944
————, and Ambedkar, Vijayakumar C., Further notes on the Baya Weaver Bird, *Ploceus philippinus* Linn. (*With a plate*) 491
Ali, S. I., *Dolichos bracteatus* Baker: Clarification of nomenclature ... 797
Ambedkar, Vijayakumar C., *see* Ali, Salim
Bal, D. V., and Mohmed, K. H., A systematic account of the Eels of Bombay. (*With fourteen text figures*) 732
————, *see* Palekar, V. C.
Banerji, Aruna, Further observations on the family life of the Five-striped Squirrel *Funambulus pennanti* Wr. ... 335
Banerjee, B., Some interesting observations on the royal chamber in the mound of the Termite *Odontotermes redemanni* (Wasmann) 203
Banerjee, Barundeb, Some common Termites of Calcutta 204
Basavanna, G. P. Channa, *see* Puttarudriah, M.
Bates, R. S. P., Fighting among Birds 191
Beatty, P. V., The changing scene: Paucity of Bird Life in Jabalpur (M.P.) 194
Behura, Basanta Kumar, *see* Panda, Upendra Chandra
Berlioz, J., The dimorphic Egrets ... 188
Best, A. E. G., Further notes and additions to the list of Butterflies from Bombay and Salsette 215

PAGE

Best, A. E. G., Notes on the Butterflies of Rangoon 776
Betts, F. N., *Halcyon pileata* inland 462
Bhardwaja, T. N., *see* Gupta, K. M.
Bindra, O. S., and Kittur, S. U., A note on the Nematode *Mermis indica* v. Linstow parasitising insects ... 796
Booth, A. H., *see* Hill, W. C. Osman
Boswell, K., 'Scent' trails and 'pooking' in Tiger 452
————, Following up wounded Tiger at night 454
Bourliere, Francois, *see* Morel, Gerard
Bowden, Evelyn, Egg-laying of the Dragonfly *Indophaea cardinalis* (Fraser) (Odonata: Insecta) 957
Boyle, C. L., Wild life preservation in India 478
Burkill, I. H., Chapters on the History of Botany in India. II. The advances, and in particular the plant collecting of the thirties and forties of the 19th century 42
Burnett, J. H., Ceylon's Wilpattu National Park (*With a plate*) 942
Burton, R. W., A Dabchick is born ... 767
————————, Homeric battles on the dinner table 961
Cantlie, Keith, Hesperiidae of the Khasi and Jaintia Hills 212
Chauhan, N. S., *see* Krishnaswami, S.
Chhapgar, B. F., On the Marine Crabs (Decapoda: Brachyura) of Bombay State. Part I. (*With one coloured and eleven line plates, and two text figures*) 399
————————, On the Marine Crabs (Decapoda: Brachyura) of Bombay State. Part II. (*With one coloured and five line plates, and one text figure*) 503
Chhapgar, B. F., *see* Kewalramani, H. G.
Chowhan, N. S., *see* Krishnaswami, S.
Crowe, Philip K., Ducks Unlimited: and Wild Life Preservation in Ceylon. (*With a plate*) 37
Daniel, A., Influence of stage of tide on the attachment of Barnacle Cyprids. (*With three graphs*) 866
De Silva, P.H.D.H., On a Zoological collecting tour of the islands off Jaffna. (*With a map*) 322

PAGE

DEB, D. B., A new Species of *Gleadovia* Gamble et Prain from Manipur. (*With a plate*) ... 799
DHARMAKUMARSINHJI, R. S., *see* SHIVRAJ KUMAR OF JASDAN
DIXIT, K. K., Differential response to form and pattern in two species of Indian Honeybees. (*With two text figures*) ... 107
DVORAK, RUDOLF, Two new species of *Priochirus* (Staphylinidae: Coleoptera) from India. (*With two text figures*) 790
EDITORS, Bird Migration in India ... 193
———, Occurrence of the Ruff and Reeve [*Philomachus pugnax* (Linnaeus)] near Coimbatore ... 464
———, Migration of Insects ... 775
———, A caterpillar-parasitising Fungus ... 973
EICHLER, WOLFDIETRICH, Notes on the Brüelia group of Mallophaga (Feather-lice) with descriptions of four new species. (*With four text figures*) ... 577
FIELD, HENRY, Ticks from Baluchistan, West Pakistan ... 469
FLEMING, R. L., The Spiny Babbler in Kathmandu Valley ... 766
GANDHI, H. P., A contribution to our knowledge of the Diatom genus *Pinnularia*. (*With twenty-one figures*) 845
GEE, E. P., The management of India's Wild Life Sanctuaries and National Parks. Part III ... 1
———, Lion *v.* Tiger ... 171
———, Predator and prey at salt-licks ... 181
GEORGE, JOSEPH, A Sunbird's unusual nesting site. (*With a photo*) ... 943
GHILDYAL, B. N., A botanical trip to the valley of flowers. (*With a sketch map*) ... 365
GIDEON, P. W., MENON, P. K. B., RAO, R. S. V., AND JOSE, K. V., Occurrence of the Echiuroid Worm *Ikedella misakiensis* (Ikeda) in Indian waters (Gulf of Kutch). (*With a text figure*) 201
———, On the Marine Fauna of Gulf of Kutch: A preliminary survey. (*With a map, one plate and five text figures*) ... 690
GOKHALE, S. V., Operation of the Dol net off the Saurashtra Coast. (*With seven text figures*) ... 714
GOLDSCHMIDT, F. R., An indigenous fishing rod and tackle. (*With a text figure*) ... 953
GOWDA, M. H. MARI, *Bougainvillea buttiana* Holttum et Standley, and its cultivars in Lalbagh, Bangalore. (*With a text figure*) ... 801
GUPTA, K. M., AND BHARDWAJA, T. N., Indian Marsileas: their morphology and systematics. 2. On the Examination of some Collections of Marsilea in India. (*With 48 figures*) ... 550
GUPTA, P. D., *see* JHA, V. R.
GUPTA, RAJ KUMAR, Botanical explorations in the Bhillangna Valley of the erstwhile Tehri Garhwal State-II 878
GURUMANI, O. N., *see* NAIR N. BALAKRISHNAN
HALL, B. P., Notes on specific identification in the Tawny Pipit (*Anthus campestris*), Blyth's Pipit (*A. godlewskii*) and Richard's Pipit (*A. novaeseelandiae*) in Asia. (*With a text figure*) ... 726
HARRISSON, TOM, Rednecked Phalarope *Lobipes lobatus* (Linnaeus) in South-east Asia ... 947
HILL, W. C. OSMAN, and BOOTH, A. H., Voice and larynx in African and Asiatic Colobidae. (*With 2 text figures*) ... 309
HU, HSEN-HSU, China's book-like rock formation with 25 million year old plant fossils ... 225
IBRAHIM, K. H., Bionomics of forage fishes: Observations on the fecundity of three common species of minor barbels. (*With one figure*) ... 826
JAIN, S. K., *see* RAIZADA, M. B.
JHA, V. R., and GUPTA, P. D., A double-headed Krait *Bungarus caeruleus* (Schneider). (*With a photo*) ... 947
JOSE, K. V., *see* GIDEON, P. W.
JOSHI, M. C., On the occurrence of *Fritschiella tuberosa* Iyeng. in Pilani (Rajasthan). (*With a text figure*) ... 970
KAPADIA, Z., *see* SANTAPAU, H.
KEWALRAMANI, H. G., and CHHAPGAR, B. F., Occurrence of a rare Sting Ray [*Taeniura melanospila* (Bleeker)] in Bombay waters. (*With one plate and one text figure*) ... 770
KHAN, NAWAB H., and ABEDI, ZILLE HASAN, Notes on the biology and control of the Lily Moth *Brithys crini* Fabricius. (*With a plate*) ... 785
KITTUR, S. U., *see* BINDRA, O. S.
KRISHNAN, D. R., Partial emergence of the Imagines of Dragonflies (Odonata) due to the absence of a holding place. (*With two figures*) ... 210
KRISHNASWAMI, S., CHAUHAN, N. S., and NEGI, P. S., Studies on non-insect Enemies of Lac with special reference to Squirrels and Birds as serious seasonal predators ... 887
———, AND CHOWHAN, N. S., A note on insects consumed as food by Squirrels and Birds at Kundri Forest, Palamau District, Bihar ... 457
KRISHNASWAMY, S., On the Harpacticoid Copepod *Phyllognathopus viguieri* (Maupas). (*With one plate*) ... 793
KULKARNY, H. L., *see* PATEL, R. C.

PAGE

LAVKUMAR, K. S., Transferring of the Indian Lion to an additional locality 173
——, The occurrence of the Pinkbreasted Parakeet (*Psittacula alexandri*) in Dehra Dun 185
——, Bird notes from Kutch 190
LOVATT, J. D., The spawning of Carps 197
MADANSINHJI OF KUTCH, Some riddles of Game-bird Migration in Kutch ... 466
MAHESHWARI, J. K., Some name changes in the Flora of India 804
MARSDEN, G. H., Solar eclipse and animal behaviour 194
MATHEW, A. P., Mating in Scorpions. (*With 3 text figures*) 853
MATHUR, S. N., and SIDHU, NARSINGH, Occurrence of *Apus* (Crustacea: Notostraca) in Pilani, Rajasthan ... 961
MEDD, H. A. N., Jumping Snakes ... 195
MENON, M. GOVINDANKUTTY, Hairless Lion Cubs in the Trichur Zoo. (*With a plate*) 450
MENON, P. K. B., *see* GIDEON, P. W.
MIRCHANDANI, TOLARAM, K., Wild Life Preservation in India: Dandeli and the Dangs 226
MOHAMED, K. H., On the occurrence of mummified eels in the internal organs of *Polydactylus indicus* (Shaw) and *Pomadasys* sp. 199
MOHAMED, K. H., *see* BAL, D. V.
MOHAPATRA, P., The 'Marala'—A sink net used in the backwaters of Ganjam, Orissa 773
MOREL, GERARD, MOREL, MARIE-YVONNE, AND BOURLIERE, FRANCOIS, The Blackfaced Weaver Bird of Dioch in West Africa: An ecological study. (*With four plates, one text figure, and three graphs*) 811
MOREL, MARIE-YVONNE, *see* MOREL, GERARD
MORRIS, R. C., Tusks of Indian Elephants 460
MOSSE, A. H., The Lion of the Gir ... 568
MOSSE, A. H. E., Reptiliana 869
MURRAY, M. E. WOLFE, Notes on the common black garden Beetle *Basilianus neelgherriensis* 206
MURTHY, D. V., The unusual resistance to starvation of *Saccharicoccus sacchari* (Ckll.) 203
NAIR, M. R. G. K., A new Pest of Screwpine in Kerala, *Agonia fuscipes* Baly (Hispinae, Chrysomelidae). (*With four figures*) 470
——, On a new Caterpillar Pest of Screwpines: *Lycaugesia longipalpis* Swinh. (Lepidoptera: Agrotidae). (*With a text figure*) ... 954
NAIR, N. BALAKRISHNAN, The Shipworms of South India with a note on the Breeding Season of *Bankia indica* Nair. (*With a plate, three text figures, and a graph*) 344
——, AND GURUMANI, O. N., Timber boring Molluscs of the Indian Coast I. Report on a Collection from Tondi and Adirampatnam, East Coast. (*With eight text figures*) 663
NAIR, N. C., and NATHAWAT, G. S., Vegetation of Pilani and its neighbourhood 91
——, Vegetation of Harsh Nath, Aravalli Hills. (*With a map*) 281
NATHAWAT, G. S., *see* NAIR, N. C.
NEELAKANTAN, K. K., Hypnotic behaviour of a Whiteheaded Babbler (*Turdoides striatus*) 460
NEGI, P. S., *see* KRISHNASWAMI, S.
PALEKAR, V. S., and BAL, D. V., Destruction of Timber by Marine Organisms in the Karwar Port. (*With a graph*) 962
PALLITHANAM, J., Observations on the Flora of Kodaikanal 835
PANDA, UPENDRA CHANDRA, and BEHURA, BASANTA KUMAR, Further observations on the biology of the common 'Tree-hopper' *Otinotus oneratus* Walk. (Homoptera; Membracidae) in Orissa 160
——, Notes on three common Tree-hoppers (Membracidae: Hemiptera) in Orissa 958
PANTHAKI, D. P., *see* SANTAPAU, H.
PATEL, R. C., and KULKARNY, H. L., Bionomics of the Pumpkin Caterpillar—*Margaronia indica* Saund. (Pyralidae: Lepidoptera). (*With a plate and a graph*) 118
PATEL, V., *see* SANTAPAU, H.
PATTNAIK, H., Some useful Weeds in and around Cuttack 140
PEPPE, J. H. H., A jumping Snake ... 948
PILLAI, N. G., Incubation period and 'mortality rate' (?) in a brood of the Magpie-robin [*Copsychus saularis* (Linn.)] 182
PRANAVANANDA, SWAMI, The Abominable Snowman 358
——, Footprints of 'Snowman' 448
PUTTARUDRIAH, M., and BASAVANNA, G. P. CHANNA, Some beneficial Coccinellids of Mysore 156
RAIZADA, M. B., A new variety of *Gymnosporia falconeri* Lawson from Northern Oudh, Uttar Pradesh ... 796
——, and JAIN, S. K., The genus *Eremopogon* Stapf, and its affinities with *Schizachyrium* Nees. (*With a plate*) 858
RAJ, J. SAMUEL, An undescribed luminous Beetle larva from South India. (*With one photograph*) ... 788

PAGE

Ramakrishnan, V., *see* Sundararaj, D. Daniel

Rao, B. R. Subha, The Biology and Bionomics of *Lestodryinus pyrillae* Keiff. (Dryinidae: Hymenoptera). A nymphal parasite of *Pyrilla perpusilla* Walk., and a note on its role in the control of *Pyrilla*. (*With a plate*) ... 741

Rao, H. Srinivasa, History of our Knowledge of the Indian Fauna through the ages. (*With two plates*)... 251

Rao, J. Sakharam, A giant form of *Celosia argentea* L. 474

————————, Grass Flora of Coimbatore District (South India) with special reference to fodder grasses 674

Rao, R. Seshagiri, *Parthenium hysterophorus* Linn., a new record for India. (*With a plate*) 218

Rao, S. R. V., *see* Gideon, P. W.

Reuben, D. E., The Abominable Snowman 762

————————, The Indian Mongoose in Jamaica 941

Ridley, M. W., Terns of the Seychelles Islands 920

Roonwal, M. L., Macaque Monkey eating mushrooms 171

Roy, J. C., and Sahoo, N., Additions to the Fish Fauna of the Chilka Lake. (*With a text map*) 949

Sahoo, N., *see* Roy, J. C.

Santapau, H., The poisonous qualities of *Calotropis gigantea* R. Br. 218

————————, *Eclipta prostrata, E. erecta,* or *E. alba* which is the correct name ? 475

————————, *Alternanthera paronychioides* St. Hil.—A correction ... 476

————————, Further notes on the Indian Species of *Curcuma* (Zingiberaceae) 966

————————, The species of *Lagenandra* of Bombay and Madras 967

————————, and Kapadia, Z., Notes on *Aerides maculosum* Lindl. (*With a text figure*) 220

————————————————, *Habenaria panchganiensis*—New name for a Bombay Orchid 478

————————, and Panthaki, D. P., Some new Plants for the Dangs Forest, Bombay State. (*With two plates*) 221

————————, and Patel, V., The Genus *Cuscuta* in Bombay. (*With a plate*) 707

————————, and ————————, *Ipomoea tropica* new name for a common Bombay Plant 798

Santapau, H., *see* Shah, G. L.

Sevastopulo, D. G., Notes on the Heterocera of Calcutta, Part III ... 153

PAGE

————————————, Notes on the Heterocera of Calcutta, Part IV ... 302

————————————, Bionomics of the Pumpkin Caterpillar, *Margaronia indica* Saund. 470

Shah, G. L., and Santapau, H., *Neuracanthus sphaerostachyus* Dalz.—Further comments 969

Shivarajkumar of Jasdan and Dharmakumarsinhji, R. S., Rednecked Phalarope (*Lobipes lobatus* Linn.) in Bhavnagar, Bombay State. (*With a plate*) 465

Shivrajakumar, Y. S., An incubating Peacock (*Pavo cristatus* Linn.) ... 464

Sidhu, Narsingh, *see* Mathur, S. N.,

Solomon, R. J., Habits of the Serow [*Capricornis sumatraensis* (Bechstein)] 941

Stracey, P. D., On the status of the Great Indian Rhinoceros (*R. unicornis*) in Nepal. (*With a map*) 763

Subramaniam, Swarna, Some observations on the Habits of the Slender Loris, *Loris tardigradus* (Linnaeus). (*With five plates*) 387

Sundararaj, D. Daniel, and Ramakrishnan, V., New Plant records for South India—II. (*With two plates*) ... 925

Szafranski, S., An episode from the life history of the Moth *Suana concolor* Walker 784

Tandon, R. S., The Liver Fluke of the Frog *Rana tigrina*—A new record of *Mehraorchis ranarum* Srivastava, 1934 (Pleurogenitinae) 468

Timm, Richard W., Marine Nematodes from the Bay of Bengal: I. Phasmidea. (*With a plate*) 87

Trehan, K. N., Brief notes on Crop Pests and their control in the Punjab (India). (*With 34 text figures*) ... 581

Turner, J. E. C., Dhaman or Rat Snake (*Ptyas mucosus*) drinking milk ... 196

Vachon, Max, The biology of scorpions. (*With a plate and 17 figures*)... 128

Vaidya, Vidyadhar, G., On the phenomenon of drumming in egg-laying female butterflies 216

Vartak, V. D., *Solanum esuriale* Lindl. A new record for Bombay State ... 965

Venkataraman, G. S., The Algal Flora of the ponds and puddles inside the Banaras Hindu University grounds, India. (*With 17 text figures*) ... 908

Venugopal, S., *Tarache nitidula* F., a semilooper Pest on Cotton in South India. (*With a plate*) 207

Vijayaraghavan, B., Drumming of the Malabar Goldenbacked Woodpecker *Brachypternus benghalensis* 461

————————————, Accidental death of a Crimsonbreasted Barbet [*Megalaima haemacephala* (Müller)] ... 462

PAGE

Vishoni, H. S., The swarming Termites of Delhi 792
Wain, F. L., Notes on some Wasps and Bees (Hymenoptera) of Poona and the Western Ghats. (*With a plate and 21 figures*) 22
————, Note on a hunting Wasp, *Notogonia jaculatrix* (Smith)... ... 957
Wan-Tho, Loke, Experiences with Little Ringed Plover. (*With a plate*) ... 185

PAGE

Wright, M. D., Notes on the Birds of a selected area of Dehra Dun—June 1946 to July 1951. (*With a sketch map*) 627
Yin, Tun, Wild Elephants in the Union of Burma 175
————, A large pair of Elephant's Tusks from Burma. (*With a photo*)... 178
————, Albino Elephants 179
————, A Python's meal 196

LIST OF PLATES

PAGE

The management of India's Wild Life Sanctuaries and National Parks. Part III.

Plate I. (Coloured) 1. Wild Elephant (*makhna*) Kaziranga, Assam ... 2. Barasingha or Indian Swamp Deer in Kanha, Madhya Pradesh ... 1
Plate II. Wild Tusker Elephant in Bandipur, Mysore ... 4
Plate III. 1. Hog Deer in Kaziranga, Assam ... 2. Mother and baby Great Indian One-horned Rhinoceros in Kaziranga, Assam ... 5
Plate IV. 1. Typical thorny scrub on the fringe of the Gir Forest ... 2. A young male Lion, with mane starting to grow, comes out to a 'kill' ... 10
Plate V. 1. A hurriedly constructed 'hide' for photographing lions ... 2. A young adult male Lion photographed from the above 'hide' ... 11
Plate VI. 1. A portable 'hide' of hessian cloth, camouflaged and in position at a salt-lick ... 2. A barking Deer buck photographed from the above 'hide' ... 18

Notes on some Wasps and Bees (Hymenoptera) of Poona and the Western Ghats

Plate Leaf-cutter Bees (*Megachile disjuncta*) in action ... 34

Ducks Unlimited: and Wild Life Preservation in Ceylon

Plate. Ducks Unlimited: Scenes in the Grey Lodge Wildfowl Refuge, California ... 38

Marine Nematodes from the Bay of Bengal: I. Phasmidea

Plate. Marine Nematodes from the Bay of Bengal A-B. *Rhabditis marina* var. *bengalensis* new var.; C-E. *Tylenchus marinus* n.sp.; F-I. *Halicephalobus limuli* n.g., n.sp. ... 90

Bionomics of the Pumpkin Caterpillar *Margaronia indica* Saund. (Pyralidae: Lepidoptera)

Plate. The Pumpkin Caterpillar *Margaronia indica* Saund: A-B. Eggs; C. Larva; D. Pupa; E. Adult ... 120

The biology of Scorpions

Plate. The Rock Scorpion (*Buthus* sp.) with young on her back ... 136

Experiences with Little Ringed-Plover

Plate. 1. Redwattled Lapwing (*Hoplopterus indicus*) ... 2. Little Ring Plover (*Charadrius dubius*) ... 186

***Tarache nitidula:* F., A semilooper Pest on Cotton in South India**

Plate. Life History Stages of *Tarache nitidula* F. on Cotton ... 208

***Parthenium hysterophorus* Linn., a new record for India**

Plate. *Parthenium hysterophorus* Linn. ... 218

Some new Plants for the Dangs Forest, Bombay State

Plate I. *Indigofera oreophila* Santapau and Panthaki ... 224
Plate II. *Moghania praecox* var. *robusta* Mukherjee ... 225

History of our Knowledge of the Indian Fauna through the ages

Plate I. 1. The mythical Yali with leonine body and elephantine face from a Hampi relief ... 2. Hunting scenes from the throne platform at Hampi in Mysore depicting antelopes, sambar and leopards ... 252

PAGE

Plate II. 1. Another form of the mythical Yali with leonine body and limbs, mane and tail but with Canine face and bovine horn and ear. From a panel of a 'mantapam' at Madurantakam in Chingleput District, Madras ... 253
2. A formal Swan with crest and curled plumes and a short neck. From a carving in wood on a doorway in Chingleput District, Madras ...

The Shipworms of South India with a note on the Breeding Season of *Bankia indica* Nair

Plate. 1. Experimental test planks of *Cedrela* sp. showing the destruction caused by Shipworms ... 346
2. Three entire shipworms (*Bankia indica*) ...

Some observations on the habits of the Slender Loris, *Loris tardigradus* (Linnaeus)

Plates. *Loris tardigradus:*
1. Position in climbing ... 387
2. Position at rest ...
3. Various positions of body and limbs ... 392/393

On the Marine Crabs (Decapoda: Brachyura) of Bombay State Part I

Plate A. 1. *Charybdis* (*Goniosoma*) *cruciata* ...
2. *Atergatis integerrimus* ...
3. *Neptunus* (*Neptunus*) *sanguinolentus* ... 399
4. *Matuta planipes* ...
5. *Charybdis* (*Goniosoma*) *lucifera* ...
6. *Neptunus* (*Neptunus*) *pelagicus* ...
Plate 1. a. *Dromia dormia* (Linnaeus) ...
b-g. *Pseudodromia integrifrons* Henderson ... 404
h-j. *Calappa lophos* (Herbst) ...
Plate 2. a-c. *Matuta lunaris* (Forskal) ...
d-f. *Matuta planipes* (Fabricius) ...
g-i. *Leucosia pubescens* Miers. ... 405
j. *Leucosia sima* Alcock ...
k-l. *Philyra globosa* (Fabricius) ...
n. *Philyra corallicola* Alcock ...
Plate 3. a-c. *Arcania septemspinosa* (Fabricius) ...
d-e. *Dorippe astuta* Fabricius ...
f-h. *Elamena cristatipes* Gravely ... 412
i-k. *Menaethius monoceros* Latreille ...
l-n. *Hyastenus planasius* (Adams & White) ...
o-p. *Doclea gracilipes* Stimpson ...
Plate 4. a-c. *Paramithrax* (*Chlorinoides*) *aculeatus* (Milne-Edwards) ...
d-f. *Schizophrys aspera* (Milne-Edwards) ...
g-i. *Lambrus* (*Platylambrus*) *prensor* Herbst ... 413
j-l. *Cryptopodia angulata* Milne-Edwards & Lucas ...
m-o. *Neptunus* (*Neptunus*) *sanguinolentus* (Herbst) ...
Plate 5. a-c. *Scylla serrata* (Forskal) ... 418
d-g. *Charybdis* (*Goniosoma*) *cruciata* (Herbst) ...
Plate 6. a-c. *Neptunus* (*Neptunus*) *pelagicus* (Linnaeus) ...
d-g. *Charybdis* (*Goniosoma*) *lucifera* (Fabricius) ... 419
h-k. *Charybdis* (*Goniosoma*) *annulata* (Fabricius) ...
Plate 7. a-c. *Charybdis* (*Goniosoma*) *callianassa* (Herbst) ...
d-g. *Charybdis* (*Goniosoma*) *orientalis* (Dana) ...
h-k. *Charybdis* (*Goniohellenus*) *hoplites* (Wood-mason) ... 424
l-n. *Thalamita crenata* Milne-Edwards ...
o-q. *Thalamita prymna* (Herbst) ...
Plate 8. a-c. *Atergatis integerrimus* (Lamarck) ...
d-f. *Atergatis floridus* (Rumph) ...
g-h. *Atergatis roseus* (Ruppell) ... 425
i-k. *Platypodia cristata* (Milne-Edwards) ...
l-n. *Xantho* (*Lophoxanthus*) *scaberrimus baccalipes* Alcock ...
o-q. *Leptodius exaratus* (Milne-Edwards) ...

PAGE

Plate 9. a-c. *Leptodius crassimanus* Milne-Edwards ...
d-f. *Leptodius euglyptus quadrispinosus* Chhapgar ...
g-i. *Medaeus granulosus* (Haswell) ... 432
j-l. *Etisus laevimanus* Randall ...
m-o. *Galene bispinosa* (Herbst) ...
p-r. *Actaea savignyi* (Milne-Edwards) ...
Plate 10. a-c. *Myomenippe hardwickii* (Gray) ...
d-f. *Ozius rugulosus* Stimpson ...
g-i. *Epixanthus frontalis* (Milne-Edwards) ... 433
j-l. *Pilumnus vespertilio* (Fabricius) ...
m-o. *Pilumnus longicornis* Hilgendorf ...
Plate 11. a-c. *Heteropanope laevis* (Dana) ...
d-f. *Eurycarcinus orientalis* Milne-Edwards ...
g-i. *Eriphia laevimana smithii* Macleay ... 438
j-l. *Eucrate crenata dentata* (Stimpson) ...
m-o. *Litocheira angustifrons* Alcock ...
p-r. *Litocheira setosa* (Milne-Edwards) ...

Hairless Lion Cubs in the Trichur Zoo

Plate. 1. Male lion cub, 3 months old, before shedding the sparse coat of hair ... 450
2. Lion cubs, hairless male and normal female, six months old ...
3. Hairless lion cub, male, about twelve months old ...

Rednecked Phalarope (*Lobipes lobatus* Linn.) in Bhavnagar, Bombay State

Plate. 1. Rednecked Phalaropes, Bhavnagar ... 465
2. Rednecked Phalaropes in flight, Bhavnagar ...

Further notes on the Baya Weaver Bird, *Ploceus philippinus* Linn.

Plate. 1. Nests in the 'bell' or 'helmet' stage ready for appropriation by hens. The cock on the right is reinforcing a new attachment ... 491
2. A newly arrived hen perches on the cross-bar or 'chin-strap', while the cock clings and flutters excitedly on the outside ...

On the Marine Crabs (Decapoda: Brachyura) of Bombay State Part II.

Plate B. 1. *Ocypoda ceratophthalma* ...
2. *Gelasimus marionis nitidus* ...
3. *Varuna litterata* ...
4. *Metopograpsus messor* ... 503
5. *Grapsus strigosus* ...
6. *Sesarma (Sesarma) oceanica* ...
7. *Gelasimus annulipes* ...
Plate 12. a-k. *Pinnotheres placunae* Hornell and Southwell ...
l-m. *Pinnotheres quadratus* Rathbun ... 506
n-q. *Pinnotheres vicajii* Chhapgar ...
Plate 13. a-c. *Ocypoda ceratophthalma* (Pallas) ...
d-f. *Ocypoda cordimana* Desmarest ...
g-i. *Ocypoda rotundata* Miers ... 507
j-o. *Gelasimus annulipes* Latreille ...
p-w. *Gelasimus marionis* (Desmarest) ...
Plate 14. a-f. *Gelasimus dussumieri* Milne-Edwards ...
g-j. *Dotilla myctiroides* (Milne-Edwards) ...
k-o. *Macrophthalmus pectinipes* Guerin ... 514
p-t. *Macrophthalmus sulcatus* Milne-Edwards ...
u-y. *Macrophthalmus latreillei* Desmarest ...
Plate 15. a-d. *Macrophthalmus pacificus* Dana ...
e-g. *Macrophthalmus depressus* Ruppell ...
h-j. *Macrophthalmus crinitus* Rathbun ...
k-m. *Grapsus strigosus* (Herbst) .. 515
n-q. *Metopograpsus messor* (Forskal) ...
r-u. *Metopograpsus maculatus* Milne-Edwards ...
v. *Varuna litterata* (Fabricius) ...
w-z. *Pseudograpsus intermedius* Chhapgar ...

PAGE

Plate 16. a-c. *Sesarma* (*Sesarma*) *quadrata* (Fabricius) ...
d-g. *Sesarma* (*Sesarma*) *oceanica* de Man ...
h-j. *Sesarma* (*Sesarma*) *taeniolata* White ...
k-m. *Sesarma* (*Sesarma*) *minuta* de Man ... 522
n-p. *Metaplax indica* (Milne-Edwards) ...
q. *Metaplax distincta* Milne-Edwards ...
r-s. *Plagusia depressa tuberculata* (Lamarck) ...

On the Marine Fauna of Gulf of Kutch: A preliminary survey

Plate. 1. *Stoicactis* sp. ...
2. *Gemmaria* sp. ... 704
3. *Ikedella misakiensis* ...
4. *Balanus amphitrite* ...

The Genus *Cuscuta* in Bombay

Plate. a. *Cuscuta reflexa* Roxb. ...
b. *Cuscuta australis* R. Br. ... 707
c. *Cuscuta chinensis* Lamk. ...
d. *Cuscuta hyalina* Roth ...

The Biology and Bionomics of *Lestodryinus pyrillae* Kieff. (Dryinidae: Hymenoptera). A nymphal parasite of *Pyrilla perpusilla* Walk., and a note on its role in the control of *Pyrilla*

Plate. 1. Egg of *Lestodryinus pyrillae* Kieffer ...
2. Fully developed *Lestodryinus* grub ...
3. Cocoon of *Lestodryinus pyrillae* on sugarcane leaf ...
4. Adult female of *Lestodryinus pyrillae* Kieffer ...
5. Adult male of *Lestrodryinus pyrillae* Kieffer ... 741
6. The modified foreleg of the female Dryinid ...
7. Hyperparasite: *Cristatithorax quadricolor* Gir ...
8. Parasitised *Pyrilla* nymph showing the development of the thylacium between the wing pads ...

Occurrence of rare Sting Ray [*Taeniura melanospila* (Bleeker)] in Bombay Waters

Plate. *Taeniura melanospila* (Bleeker) (Female) ... 772

Notes on the biology and control of the Lily Moth *Brithys crini* Fabricius

Plate. Larvae of the Lily Moth *Brithys crini* Fabricius feeding on the leaves of *Crinum latifolium* ... 785

On the Harpacticoid Copepod *Phyllognathopus viguieri* (Maupas)

Plate. *Phyllognathopus viguieri* (Maupas) ... 794

A new Species of *Gleadovia* Gamble et Prain from Manipur

Plate. a-f. *Glaedovia banerjiana* Deb ... 800

The Blackfaced Weaver Bird or Dioch in West Africa: An ecological study

Plate I. a-d. The various stages of nest construction in *Quelea q. quelea* ... 816
Plate II. 1-2. The connubial display near the still unfinished nest ... 817
Plate III. 1. Males "standing guard" on their nests. Incubation stage ... 818
2. Male feeding the young ...
Plate IV. 1. The traps used for catching immature Queleas ...
2. The aviaries for breeding experiments, Richard-Toll Ornithological Station ... 819

The genus *Eremopogon* Stapf and its affinities with *Schizachyrium* Nees

Plate. 1. *Eremopogon strictus* Camus ...
2. *E. foveolatus* Stapf ... 862
3. *E. tuberculatus* Camus ...
4. *Schizachyrium paranjpyeanum* Raizada et Jain ...

PAGE

Terns of the Seychelles Islands

Plate I. 1. White Tern, 2. Lesser Noddy, 3. Sooty Tern (adult), 4. Sooty Tern (young), 5 Crested Tern, 6. Little Tern, 7. Common Noddy, 8. Blacknaped Tern, 9. Roseate Tern, 10, Brownwinged Tern ... 922
Plate II. 1-2. An island covered with Sooty Terns is one of the most remarkable sights that an Ornithologist can see (Desnoeufs Islands) ... 923

New Plant Records for South India—II

Plate I. 1. *Lippia unica* sp. nov. ...
2. *Cenchrus glaucus* sp. nov. ... 926
Plate II. Figs. 1, 2, 6 & 8. *Cenchrus glaucus* spec. nov. ...
Figs. 3, 4, 5 & 7. *Cenchrus ciliaris* Linn. ... 927

Ceylon's Wilpattu National Park

Plate. 1. Wild Buffalo in the Wilpattu Park ...
2. Cheetal ... 942

INDEX TO ILLUSTRATIONS

VOLUME 54

Nos. 1, 2, 3 and 4

PAGE

Actaea savignyi 432
Aerides maculosum 220
Agonia fuscipes 471, 472, 473
Agrotis sp. 600
Aleurolobus barodensis 585
Allobrüelia museiberolinensis ... 579
———— *rhinocichlae* 579
Ammophila laevigata 27
Ampulex compressa 30
Amsacta moorei 593
Androctonus australis 129
———— ———— *hector* 132, 135
Anous stolidus pileatus 922
——— *tenuirostris tenuirostris* ... 922
Anthophora zonata 35
Anthus campestris 731
——— *godlewskii* 731
——— *novaeseelandiae* 731
Aplonis panayensis strigatus 580
Arcania septemspinosa 412
Archaea janata 592
Atergatis floridus 425
———— *integerrimus* 399, 425
———— *roseus* 425
Athalia proxima 612
Aulacophora foveicollis 604
Axis axis 942
Axis porcinus 5
Bagrada picta 594
Balanus amphitrite 704
——— ———— *variegatus*
Graph 1 866
——— *tintinnabulum tintinnabulum*
Graph 2 ... ... 866/867
Bankia (*Bankiella*) *edmondsoni* ... 665
——— (————) *indica* 666
——— *indica* 346, 348, 349, 350
Batocera rufomaculata 618
Bembex trepanda 30
Blackfaced Weaver Bird or Dioch in West Africa, The
Fig. 1 812
Botanical Trip to the Valley of Flowers
A Sketch map 365
Bougainvillea buttiana 803
Brithys crini 784
Brüelia fulmeki 580
——— *muniae* 580
Bubalus bubalis 942
Bungarus caeruleus 948
Buthotus alticola 130
Buthus occitanus 137
Buthus sp. 136

PAGE

Calappa lophos 404
Cedrela sp. 346
Celosia argentea 474
Cenchrus ciliaris 927
——— *glaucus* 926
Cervus duvauceli 1
Charadrius dubius 186
Charybdis (*Goniosoma*) *annulata* ... 419
———— (————) *callianassa* 424
———— (————) *cruciata* ... 399, 418
———— (*Goniohellenus*) *hoplites* ... 424
———— (*Goniosoma*) *lucifera* ... 399, 419
———— (————) *orientalis* 424
Chilo zonellus 598
Chiton 697
Chthamalus stellatus stellatus
Graph 3 ... ... 866/867
Colobus polykomos vellerosus ... 37
Crinum latifolium 784
Cristatithorax quadricolor 741
Crocisa ramosa 19
Cryptopodia angulata 413
Cuscuta australis 707
——— *chinensis* 707
——— ——— var. *ciliaris* ... 707
——— *hyalina* 707
——— *reflexa* 707
Cylindrospermum muscicola var. *macrospora* 913
Dacus cucurbitae 606
Diaphorina citri 622
Doclea gracilipes 412
Dorippe astuta 412
Dotilla myctiroides 514
Dromia dormia 404
Ducks Unlimited
Plate 38
Earias insulana 591
Elamena cristatipes 412
Elephant's Tusks from Burma, A large pair of
Photo 178
Elephas maximus 1, 4
Elis thoracica 24
Empoasca devastans 589
Epilachna sp. 605
Epixanthus frontalis 433
Eremopogon foveolatus 862
———— *strictus* 862
———— *tuberculatus* 862
Eriosoma lanigerum 615
Eriphia laevimana smithii 438
Etisus laevimanus 432

PAGE

Eucrate crenata dentata 438
Eumenes petiolata 31
Eurycarcinus orientalis 438
Fish Fauna of the Chilka Lake, Additions to the
  Map 950
Fritschiella tuberosa 971
Galene bispinosa 432
Gelasimus annulipes 503/507
——— *dussumieri* 514
——— *marionis* 507
——— ——— *nitidus* 503/507
Gemmaria sp. 704
Gleadovia banerjiana 800
Gnorimoschema operculella 609
Grapsus strigosus 503/515
Gygis alba monte 922
Halicephalobus limuli 90
Heliothis obsoleta 601
Heterometrus scaber 128, 134, 139, 854, 855, 856
Heteropanope laevis 438
Hieroglyphus banian 584
Hispa armigera 596
Hoplopterus indicus 186
Hyastenus planasius 412
Hydroprogne tschegrava 922
Icaria ferruginea 33
Idiocerus sp. 618
Ikedella misakiensis 202, 704
Indian Fauna through the Ages, History of our knowledge of the
  plate I 252
  plate II 253
Indian Honeybees, Differential Response to Form and Pattern in two species of
  Text fig. 1 109
  Text fig. 2 110
Indian Marsileas: Their Morphology and systematics 48 figures 552 & 553
Indigofera oreophila 224
Ischnurus ochropus 138
Lambrus (*Platylambrus*) *prensor* ... 413
Laphygma exigua 602
Leptocorisa varicornis 597
Leptodius crassimanus 432
——— *euglyptus quadrispinosus* ... 432
——— *exaratus* 425
Lestodryinus 741
——— *pyrillae* 741
Leucosia pubescens 405
——— *sima* 405
Lingula anatima 695
Lion Cubs in the Trichur Zoo, Hairless
  Plate 450
Lippia unica 926
Liris aurata 26
Litocheira angustifrons 438
——— *setosa* 438
Lobipes lobatus 465
Loris tardigradus
  Plate 1 387
  Plate 2 392
  Plates 3 & 4 ... ... 392/393
  Plate 5 393

PAGE

Lycaugesia longipalpis 955
Macrophthalmus crinitus 515
——— *depressus* 515
——— *latreillei* 514
——— *pacificus* 515
——— *pectinipes* 514
——— *sulcatus* 514
"Marala"—A sink net used in the backwaters of Ganjam, Orissa, The
  Text fig. 1 774
  Text fig. 2 775
Margaronia indica 120
  Graph 122
Marine Crabs (Decapoda: Brachyura) of Bombay State, On the
  Fig. 1 400
  Fig. 2 401
Marine Fauna of Gulf of Kutch, On the
  Map 692
Marine organisms in the Karwar Port, Destruction of timber by
  Graph 964
Matuta lunaris 465
——— *planipes* 399, 405
Medaeus granulosus 432
Megachile lanata 34
Menaethius monoceros 412
Metaplax distincta 522
——— *indica* 522
Metopograpsus maculatus 515
——— *messor* 503, 515
Mino dumontii kreffti 579
Moghania praecox var. *robusta* ... 225
Monophlebus stebbingi 619
Munia maja 580
Muntiacus muntjak 18
Muraena (*Gymnothorax*) *favaginea* ... 737
——— (———) *meleagris* ... 736
——— (———) *picta* ... 736
——— (———) *pseudothyrsoidea* ... 737
——— (———) *undulata undulata* ... 737
Muraenesox cinereus 735
——— *talabonoides* 734
Muraenichthys gymnopterus 733
Mutilla nobilis 23
Myomenippe hardwickii 433
Neptunus (*Neptunus*) *pelagicus* ... 399, 419
——— (———) *sanguinolentus* 399, 413
Notes on Birds of a selected area of Dehra Dun—June 1946 to July 1951
  Sketch map 627
Note on the breeding season of *Bankia indica* Nair, The shipworms of South India with a
  Graph 353
Obituary
  Photo: Norman Boyd Kinnear ... 928
  Photo: Philip McDonnell Sanderson 930
Observations on the fecundity of three common species of Minor Barbels,

PAGE

Bionomics of Forage Fishes:
Fig. 1 832
Ocypoda ceratophthalma 503, 507
———- *cordimana* 507
———- *rotundata* 507
Odynerus ovalis 32
Oedogonium lautumnarium 913
————- *rufescens* 913
Operation of the Dol net off the Saurashtra Coast
Fig. 1 715
Fig. 2 716
Fig. 3 718
Fig. 4 719
Fig. 5 720
Fig. 6 721
Fig. 7 723
Ophichthys apicalis 739
————- *cephalozona* 739
Orthochirus innesi 132
Ozius rugulosus 433
Pandinus imperator 131
Pantala 211
Panthera leo 10, 11
Paramithrax (*Chlorinoides*) *aculeatus* 413
Parthenium hysterophorus 218
Philyra corallicola 405
——— *globosa* 405
Phyllognathopus viguieri 794
Pieris brassica 603
Pilumnus longicornis 433
————- *vespertilio* 433
Pinna nigra 702
Pinnotheres placunae 506
———— *quadratus* 506
————- *vicajii* 506
Pinnularia acrosphaeria f. *undulata* ... 848
————- ———— v. *minor* ... 848
————- *aestuarii* v. *interrupta* ... 848
————- ———— v. *lata* 849
————- *angustefasciata* 848
————- *prebissonii* v. *producta* ... 849
————- ———— v. ————
f. *biundulata* 848
————- *conica* 848
————- *esox* v. *capitata* 849
————- ——- v. *fasciata* 849
————- *isostauron* 849
————- ———— v. *conifera* ... 849
————- *karnatica* 848
————- *legumen* v. *florentina* ... 848, 849
————- *microstauron* v. *ambigua* ... 848
————- *neglecta* v. *interrupta* ... 849
————- *stomatophoroides* v. *ornata*
f. *erlangensis* 848, 849
Pisoodonophis boro 738
———— *cancrivorus* 738
Placenta placenta 702
Plagusia depressa tuberculata ... 522
Platydera gossypiella 591
Platypodia cristata 425
Pleurotaenium ehrenbergii v. *crassa* ... 913
Ploceus philippinus 491
Polistes hebraeus 33
Priochirus (*Plastus*) *astoliensis* ... 790

PAGE

Priochirus (*Plastus*) *maitrta* 791
Procolobus (*Piliocolobus*) *badius waldroni* 318
Prodenia litura 594
Pseudagenia blanda 24
Pseudodromia integrifrons 404
Pseudograpsus intermedius 315
Puntius ticto 832
Pyrilla 741
Pyrilla perpusilla 584
Python's Meal, A
Photo 196
Quadraspidiotus perniciosus 614
Quelea quelea quelea ... 816, 817, 818, 819
Rhabditis marina v. *bengalensis* ... 90
Rhagophthalmus sp. 789
Rhinoceros unicornis 5
Map 763
Rhinocichla mitrata 579
Salius flavus 25
———- *madraspatanus* 26
Sceliphron madraspatanum 28
Schizachyrium paranjpyeanum ... 862
Schizophrys aspera 413
Schoenobius bipunctifer 596
Scirpophaga nivella 586
Scolia quadripustulata 23
Scorpio maurus 136
Scylla serrata 418
Sesarma (*Sesarma*) *minuta* 522
————- (———) *oceanica* 503, 522
————- (———) *quadrata* 522
————- (———) *taeniolata* ... 522
Sirogonium strictum v. *microsporum* 913
Sphex aurulentus 29
Spirogyra nitida v. *microspora* ... 913
————- *singularis* 912
————- *spreeiana* v. *kashiensis* ... 912
Sterna albifrons 922
——— *anaethetus antarctica* ... 922
——— *bergii thalassina* 922
——— *dougallii arideensis* 922
——— *fuscata nubilosa* 922, 923
——— *sumatrana mathewsi* 922
Stoicactis sp. 704
Studies on Non-Insect enemies of Lac, with special reference to squirrels and Birds as serious seasonal predators
Text fig. 888
Sunbird's unusual nesting site, A
Photo 944
Sylepta derogata 588
Taeniura melanospila 771, 772
Tarache nitidula 208
Telescopium telescopium 699
Teredo (*Zopoteredo*) *bengalensis* ... 671
——— (*Teredo*) *indica* 669
——— (———) *madrasensis* ... 668
——— (———) *navalis* 667
——— (———) *parksi* 670
——— (*Psiloteredo*) *tondiensis* ... 672
Thalamita crenata 424
————- *prymna* 424
Thrips tabaci 610

	Page
Thyrsoidea macrurus	735
Tramea	211
Trypoxylon intrudens	27
Tylenchus marinus	90
Uroconger lepturus	734
Varuna litterata	503, 515
Vegetation of Harsh Nath, Aravalli Hills	
Map	281
Virachola isocrates	621
Xantho (*Lophoxanthus*) *scaberrimus baccalipes*	425
Xylocopa latipes	36
Zoological Collection Tour of the Islands off Jaffna, On a	
Map	323
Zygnema sphaerica var. *microspora*	912

INDEX TO SPECIES

PAGE

Abies pindrow ... 366, 386
Abisara echerius angulata ... 781
Abrus precatorius ... 372
Abutilon indicum ... 142, 209, 283, 284, 286, 287, 591, 626
Acacia ... 105, 286, 298
——— arabica ... 92, 283, 289, 299, 962
——— catechu ... 643
——— decurrens ... 843
——— jacquemontii ... 95, 289, 298
——— leucophloea ... 96, 289, 298, 960
——— melanoxylon ... 843
——— modesta ... 103, 469*
——— planifrons ... 670
——— scorpioides ... 814
——— senegal 93, 285, 289, 299, 813, 814
——— tortilis ... 813, 814
Acalypha ciliata ... 295, 299
Acanthochiton ... 697
Acanthopneuste occipitalis ... 768
Acara morosella ... 470
Accipiter badius badius ... 328
——— virgatus ... 656
[Accipter =] Accipiter
Acer ... 226
Achaea janata ... 592
Acherontia styx ... 620
Achras sapota ... 97
——— zapota ... 97
Achyranthes ... 713
——— aspera ... 93, 150, 294, 883
——— bidentata ... 382, 842, 883
——— polygonoides ... 476, 477
Aconitum balfourii ... 368
——— ferox ... 969
——— heterophyllum ... 878
——— violaceum ... 366, 368
Acontia ... 589, 608
——— graellsi ... 207
Acorus calamus ... 937
Acridotheres ginginianus ... 642
——— tristis ... 641, 890, 903
——— ——— melanosternus ... 330
Acrocephalus agricola ... 768
——— dumetorum ... 768
Actaea ... 429, 432, 527
——— granulata ... 432
——— savignyi ... 432, 527, 535
Actinopteris dichotoma ... 286
Actitis hypoleucos ... 328
Adelura caeruleocephala ... 633
Adhatoda ... 285, 300, 713
——— vasica 104, 148, 283, 285, 286, 293, 294, 299, 380, 463, 628, 648
Adiantum annulatum ... 286
Adocia ... 693

PAGE

Adoretus ... 616
——— pallens ... 620
Aeginetia indica ... 380
Aegithina tiphia ... 631, 890, 903, 905
Aegle marmelos ... 95, 346, 960
Aeolarchis sphenotoma ... 470
Aeolesthes holosericea ... 616
Aerides maculosum ... 220
Aeromachus ... 783
——— ihora ... 214
——— stigmata ... 214
Aerua lanata ... 100, 150, 294
——— tomentosa 93, 283, 284, 285, 294, 299
Aeschynomene indica ... 154, 710
Aesculus indica ... 371
Aethiopsar fuscus ... 642
Aethopyga ignicauda ... 648
——— siparaja ... 648
Agathia laetata ... 153
——— lycaenaria ... 153
Agathodes ostentalis ... 306
Ageniaspis pyrillae ... 747
Ageratum conyzoides ... 291
Agestrata orichalcea ... 470
Agonia fuscipes ... 470, 473, 954
Agrimonia eupatorium ... 373
Agrostis canina ... 885
——— micrantha ... 885
Agrotera basinotata ... 305
——— scissalis ... 305
Agrotis ... 594, 600, 608
——— flamatra ... 600
——— ypsilon ... 600
Ailanthus excelsa ... 288, 298
Ailopus ... 588
Ajuga macrosperma ... 381
——— parviflora ... 381
Alauda arvensis ... 647
——— gulgula ... 647
Albizzia ... 91, 936
——— [lebbeck =] lebbek
——— lebbek 160, 161, 289, 936, 960
——— marginata ... 936
——— adoratissima ... 936, 937
Alcedo atthis ... 651
Alcemerops athertoni ... 651
Alcides porrectirostris ... 617
Alectoris graeca ... 752
Aleurocanthus husani ... 622
Aleurolobus barodensis ... 585
Alhagi camelorum ... 103, 105
Allamanda cathartica ... 97
Allium cepa ... 296, 610
——— stracheyi ... 366, 385
——— wallichii ... 367, 385, 884
Allobrüelia ... 578, 579

---

*listed as *B. Kahur*

PAGE
Allobrüelia amsel 579, 580
———— museiberolinensis ... 579
———— rhinocichlae 579, 580
Allophylus serrulatus 838
Alloteropsis cimicina 675, 679
Alnus 366
Aloe vera 101
Alphaeus 696
Alseonax latirostris 635
Alternanthera 477
———— bicolor 100
———— ficoidea 477
———— paronychioides ... 476, 477
———— polygonoides 476, 477
———— sessilis 150, 284, 285, 294
(Althaea=) Althea
Althea rosea 161, 591, 626
Alysicarpus tetragonolobus 95
Alyssum cochlearioides 804, 805
Amandava amandava 643
Amarantus 294, 298
———— gangeticus 294
———— gracilis 712
———— spinosus 150, 284, 294
———— viridis 294
Ambassis commersoni 325
Amblypodia centaurus 215
———— ———— centaurus ... 782
Ammodytes 199
Ammonites 252
Ammophila 27
———— laevigata 27
Amorphophallus campanulatus ... 151
Amphilophis insculpta 677
———— pertusa ... 674, 675, 676
———— pseudoischaemum ... 677
Amphitrite 694
Ampittia dioscorides dioscorides ... 783
Ampulex 29
———— compressa 29, 30
Amsacta moorei ... 593, 597, 599, 601, 796
Anabaena affinis 918
———— torulosa 918
Analyta melanopalis 307
———— sigulalis 307
Anaphalis araneosa 376
———— nubigena 376
———— ———— polycephala ... 881
———— royleana 376
———— triplinervis 376, 881
Anas acuta 193
—— penelope 193
—— platyrhynchos 193
Anax 210
Ancistriodes nigrita 214
Ancylolomia chrysographella ... 302
Andrachne cordifolia 383
Androctonus australis 129
———— ———— hector ... 132, 135
Andrographis paniculata 148
Andropogon 93, 858, 885
———— annulatus 105
———— delavayi ... 858, 860, 865
———— (delavyi=) delavayi
———— foveolatus 858, 859, 860, 861, 862
Andropogon foveolatus genuinus ... 858
———— ———— strictus ... 858
———— gryllus 885
———— paranjpyeanum ... 860, 865
———— pumilus 678
———— strictus 859, 860, 862
———— tuberculatus ... 858, 860, 863
Androsace lanuginosa 366, 378
———— sarmentosa 378
Aneilema divergens 385
Anemone vitifolia 368
Anemonea 693
Angelica glauca 880
Angulus 703
———— sinuata 703
Aniseia calycina 799
Anisomeles ovata 149
Anogeissus 286
———— latifolia 285, 286, 298
———— pendula ... 92, 283, 285, 289, 298
Anona squamosa 960
Anous stolidus pileatus 922
——— tenuirostris tenuirostris ... 922
Anser 662
Anthophora 34, 35
———— fallax 35
———— zonata 35
Anthus campestris 726, 731
———— ———— campestris ... 728, 730
———— ———— griseus 728
———— ———— kastschenkoi ... 728, 730
———— godlewskii 726, 731
———— hodgsoni 647
———— novaeseelandiae 726, 731
———— ———— centralariae 726, 730
———— ———— dauricus ... 726, 730
———— ———— malayensis 329, 726, 727, 730
———— ———— richardi 329, 726, 730
———— ———— rufulus 726, 727, 730
———— ———— sinensis ... 727, 730
———— ———— ussuriensis... 726, 730
———— ———— waitei 726, 727, 728, 729, 730
———— roseatus 647
———— rufulus 647
———— striolatus 726
———— thermophilus 726
———— trivialis 647
Anticharis linearis 98, 293, 299
Antigastra catalaunalis 307
Antigonon leptopus 100
Antilope cervicapra 270
Antirrhinum orontium 104
Antitrygodes 154
Apanteles flaviceps 238
Apatura camiba 216
Aphalinus mali 615
Aphanochaete repens 909, 910
Aphis gassypii ... 156, 157, 158, 590
——— maidis 156
——— malvoides 157, 158
——— (medicagenis=) medicaginis
——— medicaginis 157, 602
——— nerii 156, 157, 158, 159

PAGE
Aphis rumicis ... 157, 159
Apis ... 36
—— dorsata ... 36
—— florea ... 36, 981
—— indica ... 36, 981
—— mellifera ... 981
Aplocheilus ... 388
Aplonis panayensis strigatus ... 580
Apluda aristata ... 675, 678
Appias albina ... 215
—— —— darada ... 778
—— lyncida hippoides ... 778
Apriona cinerae ... 615
Apus ... 961, 962
Aquila heliaca ... 657
—— nipalensis ... 657
—— rapax ... 657, 824
Arachis hypogaea ... 593
Arca ... 254
Arcania ... 408
—— septemspinosa ... 408, 525, 532
Archernis tropicalis ... 307
Architectonica laevigata ... 699
Ardeola grayii ... 327, 662
—— ibis coromanda ... 328
Argemone mexicana ... 93, 141, 284, 286, 299
Argya caudata ... 630
Argyria sticticraspis ... 587
Aristida adscensionis ... 102
—— depressa ... 102, 105, 296, 684
—— funiculata ... 102, 684
—— histricula ... 296
—— hystrix ... 684
—— mutabilis ... 684
—— setacea ... 675, 684
Aristolochia bracteata ... 286, 295, 299
Arius ... 253
Arnebia hispidissima ... 98, 286, 292, 299
Arnetta atkinsoni ... 214
Artamus fuscus ... 329
Artemisia ... 710
—— parviflora ... 881
—— scoparia ... 291
—— vulgaris ... 376, 881
—— —— *v.* myriantha ... 377
Artocarpus gomeziana ... 963
—— integrifolia ... 161
Arum ovatum ... 969
Arundinella avenacea ... 683
—— fuscata ... 684
—— holcoides ... 684
—— mesophylla ... 683
—— pumila ... 684
—— setosa ... 683
Arundo donax ... 684
Asclepias curassavica ... 97
Asparagus adscendens ... 385
—— curillus ... 885
—— filicinus ... 385
—— racemosus ... 296
Asphidosiphon ... 695
Asphodelus tenuifolius ... 296, 298
(Asphoedelus=) Asphodelus
Aspidiotus auranti ... 622
Aspongopus brunneus ... 605

PAGE
Aspongopus janus ... 605
Aster asperulus ... 376
—— diplostephioides ... 376
—— thomsoni ... 376
Asteracantha longifolia ... 148
Asteria ... 694, 704
Asterolecanium ... 159
—— fusum ... 159
(Asticopterus=) Astictopterus
Astictopterus jama ... 214
—— —— olivascens ... 783
Astrea stellata ... 698
Astropecten ... 704
Astur badius ... 656
Atella phalanta ... 781
Atergatis ... 425, 527
—— floridus ... 426, 427, 534
—— integerrimus 425, 426, 527, 534
—— ocyroe ... 426
—— roseus ... 426, 527, 534
Athalia proxima ... 603, 612
Athene brama ... 655
Atherigona indica ... 600
Atriplex crassifolia ... 100
Atylosia scarabaeoides ... 372
Aucklandia costus ... 73
Aulacophora atripennis ... 604
—— foveicollis ... 604
Aularches miliaris ... 595
Aulosira fritschii ... 912, 918
Avena barbata ... 885
—— sativa ... 603
Avicennia alba ... 982
Axis porcinus ... 271
Axonopus compressus ... 679
Azadirachta indica ... 288, 937
Baccaurea ... 710
Badaniia exclamationis ... 213, 782
Bagrada picta ... 593, 594, 603, 604, 612
Balanites ... 815
—— aegyptiaca ... 813, 814
—— roxburghii ... 92, 283, 285, 288, 298
Balanus amphitrite ... 696, 866, 867, 868
—— —— variegatus ... 866
—— crenatus ... 866
—— eburneus ... 866
—— improvisus ... 866
—— tintinnabulum 696, 866, 867, 868
—— —— tintinnabulum 866
Bambusa ... 286, 664
—— arundinacea ... 102, 664
—— bambos ... 297
Bankia ... 239, 345, 351, 354, 664
—— (Bankia) bengalensis ... 345
—— (——) bipalmulata ... 345
—— (Bankiella) edmondsoni 345, 664, 665
—— (Nausitora) gabrieli ... 345, 346
—— (Bankiella) indica ... 345, 665, 666
—— indica ... 344, 346, 347, 356
—— (Neobankia) lineata ... 345
—— lineata ... 346
—— (Nausitora) madrasensis ... 345
Bankiella ... 345, 664
Baoris farri ... 215
—— penicillata ... 215

PAGE
Barachus vittatus 214
Barbus tor khudree 197
Barleria cristata 380
——— prionitis 148
Basilianus neelgherriensis 206, 207
Batagur 203, 254
Batocera horsfieldi 617
——— rufomaculata ... 617, 618, 619
Bauhinia 286
——— purpurea 654
——— racemosa 289, 298
——— reticulata 814
——— rufescens 814
——— variegata 160, 161
Begonia laciniata 879
——— picta 374
Bembex 30
——— trepanda 30
Bemisia tabaci 590, 611, 613
Berberis 368
——— chitria 368
——— lycinum 368
Bergia odorata 103
Berta 154
Beta bengalensis 609
Betula utilis 366, 384
Bibasis amara 213
——— gomata sena 213
——— harisa 213
——— jaina 213
——— oedipodea 213
——— vasutana 213
Bidens pilosa 291, 299, 376
Bischofia javanica 843
Biston suppressaria 155
Biophytum sensitivum 370
Blainvillea rhomboidea 286, 291
Blepharis boerhaaviaefolia ... 286, 294, 299
——— scindica 99
Blumea amplectens *v*. arenaria ... 805
——— ——— *v*. maritima ... 805
——— ——— *v*. pubiflora ... 805
——— ——— *v*. tenella ... 805
——— arenaria 805
——— lacera 145, 291, 300
——— obliqua 805
——— obliqua *v*. arenaria 805
——— ——— *v*. maritima ... 805
——— ——— *v*. pubiflora ... 805
——— ——— *v*. tenella 805
——— pubiflora 805
Boarmia subflavaria 155
Bocchoris acamasalis 305
——— artificialis 305
——— inspersalis 305
——— onhychinalis 305
——— rotundalis 305
Boehmeria 156, 157, 158, 713
——— platyphylla 384
Boenninghausenia albiflora 371, 879
(Boerhavia=) Boerhaavia
Boerhaavia diffusa ... 93, 105, 150, 282, 283, 284, 286, 294, 381
——— repens 286, 294
Bombax malabaricum ... 94, 370, 963

PAGE
Borassus flabellifer ... 346, 663, 665, 667, 668, 672, 673
Borbo bevani 214
——— cinnara 783
Bos bubalus 255, 270
——— gaurus 255
——— indicus 254, 255
Botia striata *v*. kolhapurensis ... 980
Botrydium 970
——— granulatum 916
——— tuberosum 916
Botryllus 705
Botyodes asialis 305
——— flavibasalis 305
Bougainvillea 803, 804
——— buttiana 801, 802, 803, 804
Brachiaria distachya 675, 680
——— eruciformis 680
——— mutica 680
——— paspaloides 102
——— ramosa 102, 297, 300, 674, 675, 680
——— semiundulata 680
——— semiverticillata 680
Brachycaudus pruni 616
Brachypternus benghalensis 461, 462, 649, 890, 900, 902, 905
Bradina admixtalis 304
Branchipus 962
Brassica campestris *v*. sarson ... 626
——— juncea 626
——— napus 603, 626
——— rapa 603, 626
Breynia rhamnoides 101
Bridelia stipularis 101
Brithys crini 785, 786, 787, 788
Brüelia 577, 580
——— cyclothorax 578
——— fulmeki 580
——— muniae 580
——— nebulosa 578, 580
———trithorax 578
Brumus suturalis 159
Brunella vulgaris 883
Bryonia lacinoisa 96
Bucklandia populnea 838
Bufo fergusonii 326
——— melanostictus ... 326, 332, 334, 752
Bulbochaete 911
Bulla 701
——— ampula 701
Bungarus caeruleus 947
Bunodactys 693
Burhinus oedicnemus 659
Bursa tuberculata 700
Bursera 346
Butastur teesa 657
Butea 891
——— monosperma 103, 457, 887
Buteo rufinus 657
Buthotus alticola 130
Buthus 138
——— occitanus 137
Butorides javanicus 662
——— striatus javanicus ... 327
Cacomantis passerinus 653

PAGE

Cadaba farinosa 713
Caesalpinia pulcherrima 95
Caesulia axillaris 376
Cajanus indicus 160, 162, 960
Calaenorrhinus asmara concertus ... 783
Calappa 404
——— (Lophos) lophos 404
——— lophos ... 404, 524, 532, 542
Callianche 709
Callicarpa arborea 368, 380
Calligonum polygonoides 92, 105, 283, 284, 295, 299
Calliope pectoralis 633
Calophyllum 963
——— inophyllum 160, 161
Calornis payanensis 580
Calotes 496, 869
——— versicolor 327, 332
Calothrix fusca 917
Calotropis ... 156, 157, 159, 218, 285, 294, 308, 713
——— gigantea ... 146, 158, 159, 207, 209, 218, 257, 292, 299, 960
——— procera ... 93, 105, 218, 283, 284, 292, 299, 962
Caltoris bromus 215
——— cahira 215
——— ——— austini 784
——— cormasa 215
——— kumara 215
——— sirius 215
——— tulri 215
Calodon 705
Camellia scottiana 57
——— theifera 57
Campanula canescens 378
Camponotus (Tanaemyrmex) compressus 160, 162, 959
——— compressus 459, 959
Cancer (Galene) bispinosus ... 431
——— (Atergatis) floridus 426
——— (Actaea) granulatus 432
——— (Atergatis) integerrimus ... 425
Cannabis sativa 383, 654
Canscora diffusa 147
Capila jayadeva 213
——— pennicillatum 213
——— phanaeus 213
——— pieridoides 213
Capillipedium filiculmis 676
——— huegelii 676
Capodacus erythrinus 643
Capparis decidua 92, 283, 284, 286, 287, 299
Capra falconeri 271
Capricornis sumatraensis 941
Caprimulgus asiaticus eidos 329
——— macrurus 652
Caprinia conchylatis 305
Caprona agama 214
——— ——— agama 783
Capsella bursa-pastoris 367, 369
Capsicum annum 613
——— frutescens 292
Carapa 346
Cardiospermum haticacabum ... 288

PAGE

Cardium asiaticum 702, 703
——— coronatum 703
Carduelis caniceps 644
Carex filicina 885
——— nubigena 885
Carissa 713
——— carandas 155
——— spinarum ... 368, 371, 372, 378, 385
Carniotome versicolor 381
Carpinus 226
Carpomyia vesuviana 620
Carteria cordiformis 908
Carya 226
Cassia fistula ... 155, 160, 161, 302, 305, 960
——— obovata 95
——— occidentalis 144, 289, 299
——— siamea 95
——— (toara=) tora
——— tora 95, 105, 289, 711
Cassiope fastigiata 366, 367, 378
Cassytha 707
Castalius rosimon rosimon 781
Casuarina 963
Catachrysops strabo 781
Cataclysta fuscalis 304
Catla 198, 834
——— catla 833
Catopsilia crocale 778
——— florella gnoma 778
——— pomona 778
——— pyranthe 778
——— ——— minna 778
Cautleya spicata 884
Cedrela 295, 346
——— toona ... 285, 288, 299, 346, 371, 627
Cedrus deodara 386
——— libani 368
Celaenorrhinus asmara 213
——— aurivittata 213
——— badia... 213
——— dhanada 213
——— leucocera 213
——— munda 213
——— nigricans 213
——— plagifera 213
——— platula 213
——— putra 213
——— pyrrha 213
——— ratna 213
——— zea 213
Celastrus paniculata 371
Cellana (Patella) 691
Celosia argentea ... 100, 150, 294, 474
Celtis australis... 383
——— tetrandra 843
——— wightii 843
Cenchrus 93, 105
——— biflorus 93, 284, 296
——— catharticus ... 282, 283, 296, 299
——— ciliaris 102, 674, 675, 683, 926, 927
——— glaucus 925, 926, 927
——— [prieri=] prurü
——— prurii 102, 296, 300
——— setigerus 674, 675, 683
Centotheca lappacea 688

PAGE

Centropus sinensis ... 183, 191, 654, 890, 903
———— ———— intermedius ... 183, 185
———— ———— parroti 183, 184, 185, 329
———— ———— sinensis ... 183, 184, 185
Cephalandra indica 144, 290
Cephrenes chrysozoa 214
Ceratina viridissima 34
Cerceris 31
——— humbertiana 30
Cerchneis amurensis 463
Cercocebus 314
———— albigena 311
Cercomela fusca 632
Cercopithecus aethiops 314
———— campbelli 313, 314
———— diana 314
———— lowei 310
———— mona 313, 314
———— petaurista ... 311, 313, 314
Cerianthus 694
Cerithium 699
Ceropegia tuberosa 97, 292, 298
Certhia himalayana 632
Cervus 254
——— affinis 755
Ceryle rudis 651
——— ——— leucomelanura 329
Cestrum 713
——— nocturnum 98
Cethosia cyane 781
Chaetophora pisiformis 910
Chaimarrhornis leucocephalus ... 633
Chalcophaps indica 214
Chapra mathias 595
Characium ambiguum 908
Charadrius alexandrinus seebohmi ... 328
———— dubius 185
———— ———— curonicus ... 328
———— jerdoni 660
Charaxes polyxena hierax 780
Charybdis 419, 526
———— (Goniosoma) annulata ... 420, 526, 533
———— annulata 421
———— (Charybdis) callianassa ... 420
———— (Goniosoma) callianassa 421, 526, 534
———— callianassa 421
———— (Goniosoma) cruciata ... 418, 526, 533
———— cruciata 419
———— (Goniosoma) cruciatus ... 419
———— (Goniosoma) crucifera ... 419
———— (Goniohellenus) hoplites 423, 526, 534
———— hoplites 423
———— lucifer 420
———— (Goniosoma) lucifera 420, 526, 533
———— (Charybdis) luciferae ... 420
———— (————) orientalis ... 422
———— (Goniosoma) orientalis ... 422, 526, 534
———— orientalis 422
———— (Goniosoma) quadrimaculata 420

PAGE

Cheiloneurus pyrillae 747
Cheiranthus cherii 93
Chela phulo 833, 834
Chelidorhynx hypoxanthum ... 637
Chelonodon patoca 325
Chenopodium album 295
———— glaucum 100
———— murale 295
Cheritra freja freja 782
Chibia hottentotta 190, 639
Chilades laius laius 781
Chilasa clytia onpape 777
———— ———— v. dissimilis 777
Chilo suppressalis 302
——— trypetes 587
——— zonellus 238, 598, 599
Chilomenes 6-maculatus 159
Chionachne koenigii 675
———— semiteres 675
Chiton 691, 696, 697
Chitra 253
Chlamis singaporina 702
Chlidonias hybrida 661
———— leucoptera 328
Chloeres 154
Chlorella vulgaris 909
Chlorinoides 413
———— acubatus 413
Chlorinus aculeatus *v.* armatus ... 413
Chloris barbata 296, 675
——— incompleta 687
Chloroclytis 155
Chlorodryinus 747
———— pallidus 741, 747
Chlorophytum 239
Chloropsis aurifrons 631
Choaspes benjaminii 213
———— hemixanthus 213
———— plateni 213
———— xanthopogon 213
Chomelia asiatica 840
Chorinemus sancti-petri 951
Chromodoris 701
———— universitata 701
Chrotogonus 587, 597, 598, 600
Chrozophora obliqua 295, 300
Chrysocolaptes guttacristatus ... 649
Chrysomma sinensis 630
Chrysopa lacciperda 887
———— madestes 887
Chrysophrys datnia 952
Chrysopogon hackelii 677
———— montanus ... 385, 675, 677
———— orientalis 677
———— verticillatus 677
———— zeylanicus 677
Chthamalus stellatus 867, 868
———— ———— stellatus ... 866
Cicer arietinum 600
Ciconia ciconia 191
——— nigra 661
Cinnamomum camphora 653
———— wightii 842
Cinnyris asiaticus 648

PAGE
Ciona ... 705
Circaea alpina ... 374
Circus aeruginosus ... 656
——— ——— aeruginosus ... 328
——— macrourus ... 328
Cirphis ... 796
——— unipuncta ... 599
Cirrhina mrigala ... 833, 950
Cirrhochrista brizoalis ... 303
Cissampelos hexandra ... 141
——— pareira ... 368, 713
Cistanche ... 105
Cisticola juncidis ... 639
Citrullus colocynthis ... 93, 105, 284, 290, 299
——— fistulosus ... 626
——— vulgaris ... 290, 626
Citrus medica ... 95, 621
——— ——— *v.* acida ... 95
——— ——— *v.* galgala ... 626
——— ——— *v.* limetta ... 95
——— ——— *v.* medica ... 95
——— sinensis ... 626
Cladophora glomerata ... 909
Clamator coromandus ... 328
——— jacobinus ... 653
——— ——— jacobinus ... 328
Clanculus ... 698
——— depictus ... 698
Clanis pallidula ... 158
Clavellina ... 705
Cleistogrammica ... 709
Clematis gouriana ... 368
——— munroana ... 836
Cleome papillosa ... 93, 287, 299
——— viscosa ... 93, 141, 283, 287
Clerodendrum ... 285
——— inerme ... 99, 149, 713
——— (phlomidis=) phlomoides
——— phlomoides 93, 283, 285, 294, 298
——— (phlomoidis=) phlomoides
Clitoria ternatea ... 144
Closterium acerosum ... 914
——— cornu ... 914
——— decorum ... 914
——— ehrenbergii ... 914
——— lineatum ... 914
——— pusillum ... 915
Clypeaster ... 704
Cnaphalocrocis medinalis ... 305
Cnicus wallichii ... 93, 97, 291, 298, 300
Coccinella arcuata ... 159
——— septempunctata ... 602
——— (septumpunctata=) septempunctata
Coccinia indica ... 118, 119, 124, 283
Cocculus cebatha ... 93
——— villosus ... 140, 299
Cochlearia alyssoides ... 804
——— cochlearioides ... 804
——— flava ... 804, 805
Cocoecia ... 616
Cocos nucifera ... 346
Coelioxys decipiens ... 34

PAGE
Coelophora ... 159
Coilia dussumierii ... 715
Coix gigantea ... 675
Coladenia agni ... 213
——— dan fatua ... 213
——— dan festa ... 213
——— fabia ... 213
——— indrani ... 213
Colebrookea oppositifolia ... 380, 883
Coleochaete scutata ... 910, 911
Coleus barbatus ... 365, 380
Colisa lalius ... 952
Collocalia brevirostris unicolor ... 329
——— francica ... 945
——— innominata ... 945
Colobus 309, 315, 316, 318, 319, 320, 321
——— polykomos ... 311, 316
——— ——— dollmani ... 311
——— ——— vellerosus ... 316, 317
Colquhounia coccinea ... 381
Columba livia ... 658
Comibaena ... 153
Commelina benghalensis ... 151, 284, 296
——— obliqua ... 296, 299
Comostola confusa ... 154
——— laesaria ... 154
Conchrus ... 93
Convolvulus calycinus ... 799
——— glomeratus *v.* volubilis 712
Copsychus saularis ... 182, 634
——— ——— ceylonensis ... 329
Copitha purreea ... 214
Coptotermes ... 205
——— heimi ... 205, 792, 793
Coracias benghalensis ... 650
——— ——— indica ... 329
Coracina novaehollandiae layardi ... 329
Corchorus ... 105
——— acutangulus 93, 142, 283, 284, 287
——— antichorus ... 94, 105
——— tridens ... 283, 284, 287, 299
——— trilocularis ... 287, 299
——— urticaefolius ... 94
Cordia myxa ... 292, 299
Cordiceps ... 973
——— sinensis ... 973
Coriandrum sativum ... 290
Coriaria nepalensis ... 75
Cornus capitata ... 375
Coronopus didyma ... 93
Corvus macrorhynchos ... 628
——— ——— culminatus 330
——— splendens ... 271, 628
——— ——— protegatus ... 330
Corydalis cachemiriana ... 369
——— longipes ... 369
——— meifolia ... 878
——— nana ... 367, 369
Corylus colurna ... 366, 384
Cosmarium depressum ... 915
——— nitidulum ... 915
Cosmophila indica ... 207
Cosmos bipinnatus ... 161
Cotoneaster bacillaris ... 366, 373

PAGE
Cotoneaster microphylla 373
Cotula alba 476
Crambus atkinsoni 302
Craspedia 154
———— cleoraria 154
———— emissaria 154
———— fibulata 154
———— nictata 154
———— opicata 154
———— remotata 155
Crataegus crenulata 373
Crataeva religiosa 103
Cremanthodium oblongatum ... 882
Crenidens indicus 952
Crinum asiaticum 101, 785
——— latifolium 101, 785
Cristatithorax quadricolor 746, 749
Crocidolomia binotalis 307
Crocidophora ptyophora 307
Crocisa 34
——— emarginata 34
——— ramosa 35
Crocodilus palustris 272, 769
———— porosus 272
Crocopus phoenicopterus 657
Crossoptilon harmani 755
Crotalaria burhia ... 93, 105, 282, 289, 299
———— juncea ... 95, 144, 591, 626
(Crotolaria=) Crotalaria
Croton 710
——— sparsiflorus 100, 143
Crozophora obliqua 100
Cryptocorine 968, 969
———— meeboldii 968, 969
Cryptolepis buchanani 649
Cryptopodia 415
———— angulata ... 415, 526, 533
Cryptostegia grandiflora 97
[Crysopogon=] Chrysopogon montanus
Ctenolepis cerassiformis 96, 290, 299, 300
Ctenoptilum vasava 214
Cuculus canorus 652
——— micropterus 653
Cucumis sativus 290, 626
——— trigonus 96, 286, 290
Cucurbita maxima 290
———— moschata 96
———— pepo 119
Culicicapa ceylonensis 636
Cuon alpinus 270
Cupha erymantus lotis 781
Cupressus torulosa 385
Curcuma 966, 967
——— inodora 966
——— pseudomontana 966
Curetis 441
Cuscuta 105, 707-713
——— arabica 711
——— australis 707, 708, 709
——— boissieri 711
——— capitata 379
——— chinensis ... 707, 708, 709, 710
——— ——— v. ciliaris 707, 708, 709, 711
——— ciliaris 711

PAGE
Cuscuta europaea 708
——— grandiflora 712
——— hyalina 293, 298, 299, 707, 710, 711
——— reflexa 98, 147, 293, 298, 707, 708, 212
——— sulcata 710
Cyamopsis psoralioides 289, 626
Cyananthus 367
———— integer 377
———— linifolius 378
———— lobatus 377, 882
Cyanosylvia svecica 633
Cyanotis 296
———— axillaris 296, 299, 300
Cyathula tomentosa 883
Cybister tripunctatus asiaticus ... 961
Cycas revoluta 103
Cymbopogon 679
———— caesius 679
———— coloratus 675, 678
———— confertiflorum ... 678
———— flexuosus 675, 678
———— gidarba 679
———— martini 678
———— parkeri 102
Cylindrospermum muscicola v. macrospora 918
[Cynanthus=] Cyananthus lobatus
Cynodon barbata 688
——— barberi 687
——— bournei 688
——— dactylon 151, 285, 296, 675, 687
——— ——— v. intermedius ... 687
——— montana 688
——— polystachya 688
Cynoglossum wallichii 379
Cynopterus 498
Cyperus arenarius 195, 296, 299
——— nubigena 885
——— rotundus ... 93, 151, 284, 285, 296
Cypraea 254, 700
——— arabica 700
——— ocellata 700
Cypselus 498
Cyrotococcum longipes 682
———— oxyphyllum 682
———— patens 682
———— radicans 682
———— trygonum 675, 682
Dactyloctenium aegyptium 284, 297, 675, 688
———— scindicum 102
Dacus cucurbitae 606
——— ferrugineus 619
——— zonatus ... 606, 617, 619, 622
Daimio bhagava bhagava 783
——— phisara 214
——— sinica 214
Dalbergia 91, 654
——— latifolia 963
——— sissoo 289, 372
Damonia 253
Danais aglea melanoides 779
——— agleoides 779
——— chrysippus 779
——— limniace mutina 777, 779

Page

Danais melanippus indicus 779, 780
——— mellissa septentrionis ... 779
——— plexippus 779
——— similis vulgaris 779
Danthonia kashmiriana 886
Daphne cannabina 382
——— papyracea 884
Darpa hanria 213
Datura fastuosa 160, 292
——— stramonium 882
Daucus carota 290, 375
Deba surrectalis 305
Debregeasia hypoleuca 384
——— velutina 844
Deeringia celosioides 382
Delias eucharis 778
——— hyparete 778
——— ——— hierte 778
——— thysbe pyramus 778
Delphinium vestitum 878
Demiegretta 188
——— sacra 188, 189
Dendrelaphis 327
Dendrobium alpestre 384
Dendrocalamus strictus 689
Dendrocitta formosae 629
——— vagabunda 629
Dendrophis 257
Dendrostoma 695
Dentalium 697
——— octangulatum 697
Desmodium concinnum 372
——— floribundum 372
——— gangeticum 289
——— oxyphyllum 372
——— parvifolium 372
——— reniforme 372
Desmostachya bipinnata 102
Deudoryx epijarbus amatius ... 782
Deutzia corymbosa 373
Deyeuxia sylvatica 886
Diadord 698
Dialeurodes citri 622
Dianthera 710
Diaphorina citri 622
Diasemia ramburialis 307
Diaspis echinocacti 158
Diathetes pandanae 470
Dicaeum ignipectus 649
Dichanthium annulatum 677
——— caricosum 102, 677
——— nodosum 677
Dichocrocis evaxalis 305
——— punctiferalis 305
[Dichoma=] Dicoma
Dichrostachys cinerea 285, 286, 289, 298, 300
Dicoma tomentosa ... 96, 285, 291, 299
Dicrurus longicaudatus 191
——— macrocercus 639, 890, 901, 903
——— ——— minor ... 330
Digera arvensis 294, 298
Digitaria 710
——— adscendens ... 102, 286, 296, 300
——— griffithii 679

Digitaria longiflora 102, 679
——— marginata ... 105, 296, 675, 679
——— ——— v. fimbriata ... 679
——— royleana 679
Digitaria sanguinalis 102
(Digitatlis=) Digitalis purpurea ... 842
Dilinia medardaria 155
Dinebra retroflexa 688
Dinopium benghalense jaffnense ... 329
Diogenes 696
Dioscorea sativa 385
Dipsacus inermis 367, 375, 880
Dipterocarpus alatus 945
Dirades adjutaria 153
——— theclata 153
Dissoura episcopus 661
Ditylenchus 90
Doclea 412
——— gracilipes 412, 525, 533
Docophorulus 577
Dodonaea viscosa 838
Dolichoris 613
Dolichos biflorus 95
——— bracteatus 797, 798
——— ghaticus 797, 798
——— lablab 158, 626
Donax 703
——— scrotum 703
Doratanthera linearis 98
Dorippe 409
——— astuta ... 409, 524, 532, 542
Dosinia 703
Dotilla 511
——— myctiroides ... 511, 529, 537, 543
Dracaena angustifolia 101
Dromia 401
——— dormia 401, 402, 525, 532, 542
——— rumphii 401
Drosera lunata 374
Dryobates auriceps 649
——— mahrattensis 461, 890, 900, 901, 902, 904
Dryocalamus nympha 327
Dryocopus hodgei 461
——— javensis 461
Dubyaea 377
Duranta 654
——— repens 713
(Dychrostachys=) Dichrostachys
Dysdercus cingulatus 590, 608
Earias 608
——— fabia 590
——— insulana 590, 591
Eburna 254
Echeneis naucratus 952
Echinochloa [colona=] colonum
——— colonum 102, 674, 675, 681
——— crus-galli 681
——— stagnina 102, 681
Echinops echinatus 97, 105
——— niveus 377
Echis carinata 195, 327, 332, 333, 334
——— [carinatus=] carinata
Eclipta 475

PAGE

Eclipta alba 145, 291, 475, 476
——— erecta ... 284, 285, 475, 476
——— prostrata 475, 476
Ectenascidia thurstoni 705
Edgeworthia buxifolia 73
Egretta asha 189
——— dimorpha 189
——— garzetta 188, 189
——— gularis... ... ... 189, 190
——— schistacea 189
Elaeocarpus oblongus 837
——— tuberculatus 837
Elamena 409
——— cristatipes 409, 525, 533
Elanus caeruleus vociferus 656
Elasmus 904
——— claripennis 891
Elatostema sessile 384
[Eleocarpus =] Elaeocarpus
Elephantopus scaber 286, 291, 298, 300
Elephas maximus 175, 178, 179, 236, 254, 560
Eleusine indica 688
——— lagopoides 688
——— scindica 102
——— verticillata 102, 688
Elis annulata 24
—— asiatica 24
—— thoracica 23, 24
Elshottzia strobilifera 380
Elymnias hypermnestra tinctoria ... 780
——— ——— undularis ... 779
Elytraria 293
——— crenata 286, 299
Emberiza cia 645
——— fucata 645
——— melanocephala 190, 645
——— stewarti 645
Emmalocera depresella 587
Empoasca 592, 598
——— devastans ... 589, 607, 608, 609, 611
——— punjabensis 609, 611
——— solanifolia 609
Endotricha decessalis 303
——— ruminalis 303
Enhydra fluctuans 145
Enneapogon elegans 688
Enteropogon monstachyos 687
Entada scandens 960
Entomophthora 974
Ephedra foliata ... 93, 105, 297, 298, 299
Epicrocis aegnusalis 303
Epilachna 611
——— dodecastigma 606
——— dumerili 605
——— vigintictopunctata ... 606
[Epilachnai =] Epilachna
Epilobium 367
——— roseum 367, 374, 879
——— royleanum 374
Epimys brachma 755
Epinephelus tauvina 325
Epixanthus 434
——— frontalis 434, 528, 535
Equus caballus 254
Equus hemionus khur 271
Eragrostis 93, 105
——— amabilis 385
——— aspera 685
——— bifaria 675, 687
——— brachyphylla 687
——— cilianensis 686
——— ciliaris 685
——— cynosuroides 102
——— diarrhena *v.* koenigii ... 686
——— gangetica 102, 686
——— minor 102
——— nigra 686
——— nutans 686
——— pilosa 675, 686
——— plumosa 102, 686
——— poaeoides 686
——— tenella 385
——— ——— *v.* plumosa ... 686
——— ——— viscosa 385
——— tenuifolia 686
——— unioloides 686
——— viscosa 102, 686
——— willdenoviana 686
Ercta ornatalis 305
Eremopogon 858-865
——— delavayi 860, 865
——— foveolatus 675, 678, 858, 859, 860, 861, 862, 865
——— paranjpyeanum ... 860, 865
——— [paranjpyenum =] paranjpyeanum
——— strictus 859, 860, 861, 862, 864
——— tuberculatus ... 860, 861, 863
Eremopteryx grisea 648
——— ——— ceylonensis ... 329
Eremotermes paradoxalis 792, 793
Erigeron 376
——— linifolius 376
——— multiradiatus 881
——— obliquum 805
Eriobotrya 226
——— japonica 626
Eriocheir sinensis 543
Eriochloa procera 680
Erionota acroleucus 214
——— thrax 214
——— ——— thrax 783
——— torus 214
Eriosoma lanigerum 615
Eriphia 437
——— laevimana smithii ... 437, 527, 536
——— smithii 437
Erolia temminckii 328, 661
——— testacea... 328
Ervatamia coronaria 97
——— dichotoma 97
——— divaricata 97
Erythrina 641
——— suberosa 95
Erythrocebus 314
——— patas 314
Erythropus amurensis 463
Esacus recurvirostris 659
Esomus danricus 950

PAGE

Estheria ... 962
Etiella zinckenella ... 303
Etisus ... 431
——— laevimanus ... 431, 527, 535
Etroplus maculatus ... 326
Eublemma ... 899, 904
——— amabilis 887, 890, 891, 896, 897
——— olivacea ... 607
Eucalyptus ... 161, 836, 838
——— acmenoides ... 838
——— amygdalina ... 838
——— calophylla ... 838
——— corynocalyx ... 838
——— crebra ... 838
——— diversicolor ... 838
——— eugenioides ... 838
——— ficifolia ... 838
——— globulus ... 838
——— gonocalyx ... 838
——— gunnii ... 838
——— haemastoma ... 838
——— hemiphloia ... 838
——— longifolia ... 838
——— maculata ... 839
——— macrorrhynchia ... 839
——— microcorys ... 839
——— obliqua ... 839
——— paniculata ... 839
——— paucifolia ... 839
——— pilularis ... 839
——— piperita ... 839
——— punctata ... 839
——— resinifera ... 839
——— robusta ... 839
——— rostrata ... 839
——— rudis ... 839
——— saligna ... 839
——— salmoniphloia ... 839
——— santalifolia ... 839
——— sieberiana ... 839
——— stricta ... 839
——— stuartiana ... 839
——— tereticornis ... 839
——— viminalis ... 839
Euchelus ... 698
——— asper ... 698
——— indicus ... 698
Euchloris quantula ... 154
——— subtiliaria ... 154
Euchrysops enejus ... 781
Euclasta defamatalis ... 306
Eucrate ... 437
——— crenata ... 438
——— ——— dentata ... 437, 527, 536
——— ——— *v.* dentata ... 437
Eudynamis scolopacea scolopacea ... 329, 653
——— (scolopaceus =) scolopacea
Eugenia jambolana ... 154, 161, 374, 626, 890
——— malaccensis ... 161
Euglena viridis ... 916
Eugrammica ... 709
Eulalia phaeothrix ... 676
Eumelea ludovicata ... 153
——— rosalia ... 153

PAGE

Eumenes ... 31, 32
——— affinissima ... 31
——— conica ... 31
——— esuriens ... 31
——— flavopicta ... 32
——— petiolata ... 31
Eumyias thalassina ... 636
Eupatorium glandulosum ... 841
Euphorbia ... 105, 298
——— clarkeana ... 295, 298
——— dracunculoides ... 100
——— geniculata ... 383
——— hirta ... 143, 295, 383
——— hypericifolia ... 286, 295
——— jodhpurensis ... 105
——— microphylla ... 295, 299
——— millii ... 100
——— neriifolia 104, 105, 285, 286, 293, 295
Euphorbia nivulia ... 105
——— pilosa ... 383, 884
——— pilulifera ... 143, 295
——— prolifera ... 383
——— rothiana ... 843
——— royleana ... 104, 105, 378, 383
——— splendens ... 100
Euplax bosci ... 515
Euploea ... 779
——— crossa ... 215
——— godartii ... 779
——— mulciber mulciber ... 779
(Euprocitis =) Euproctis
Euproctis fraterna ... 592, 620
——— lunata ... 592, 620
Eurrhyparodes bracteolalis ... 305
——— tricoloralis ... 305
Erycarcinus ... 436
——— orientalis ... 436, 528, 535
Eurydema ... 613
Eurythoe ... 694
Euscorpius ... 138, 853
Eutermes ... 206
——— horni ... 206
Eutetranychus banksi ... 157
Euthalia garuda garuda ... 780
——— lepidea sthavara ... 780
——— lubentina ... 216
——— ——— indica ... 780
Euxoa ... 600
Euzophera perticella ... 303, 607
Evolvulus alsinoides ... 147, 293
Fagonia ... 105
——— arabica ... 288, 299
——— bruguieri ... 95
Fagopyrum esculentum ... 382
Falco chicquera ... 657
——— peregrinator ... 656
——— tinnunculus tinnunculus ... 328
Farsetia hamiltonii ... 93, 105, 286, 299
——— jacquemontii ... 105, 286, 299
——— (jaquemontii =) jacquemontii
Fascioloria ... 254
Favia ... 254, 694
Feronia elephantum ... 95

PAGE
Ficula laevigata 700
Ficus 91
—— bengalensis 295, 960
—— (benghalensis=) bengalensis
—— carica 617
—— hispida 844
—— glomerata 101, 119, 893
—— religiosa 295
Filia 226
Filodes fulvidorsalis 305
Fimbriaria 286
Fimbristylis squarrosa 296, 300
Firmiana 226
Formenkreis 311
Fringilla montifringilla 578
Fritschiella 971
—— tuberosa 970, 971, 973
Flacourtia indica 713
Flemingia vesita 372
Fluggea leucopyrus 100
Foeniculum vulgare 375
Fragaria indica 372
Francolinus francolinus 659
—— pondicerianus 659
—— —— ceylonensis 328
Franklinia gracilis 639
Fuchsia corymbiflora 839
Funambulus palmarum brodiei 330
—— pennanti 335, 434, 457, 889, 894
Funaria 286
Gafrarium 703
Galene 431
—— bispinosa 431, 527, 535
Galeodes 961
Galerida cristata 648
Galerucella singhara 613
Galinsoga parviflora 841
Galium aparine 375
—— aspeifolium 375, 880
—— rotundifolium 880
Galleria mellonella 302
Grallinago 661
—— solitaria 661
(Gallium=) Galium 800
Gallus gallus 659
—— sonnerati 946
Gangara thyrsis 214, 215
—— —— thyrsis 783
Gardneria ovata 841
Garnotia scoparia 684
Garrulax leucolophus 629
Gavialis gangeticus 254, 272, 769
(Gavialus=) Gavialis
Gaultheria trichophylla 367, 378
Gelasma goniaria 154
Gelasimus 507, 508, 528, 696
—— acutus 511
—— annulipes 508, 510, 528, 531, 537, 543
—— dussumieri 510, 511, 529, 537
—— marionis 509, 510, 529, 537
—— —— nitidus 510, 529, 537
—— —— *v.* nitidus 510
—— urvillei 511

PAGE
Gelochelidon nilotica nilotica 328
Gemmaria 694
Gennaeus leucomelanus hamiltonii 659
Gentiana argentea 379
—— decemfida *v.* aprica 379
—— pedicellata *v.* wightii 841
Geokichla citrina 634
Geranium 366
—— collinum 370
—— nepalense 370
—— ocellatum 370
Gerardinia heterophylla 383
Gerbera lanuginosa 377
Gerres oyena 325
Gerydus boisduvali assamensis 781
Geum 366
—— elatum 367, 372
Gisekia pharnaceoides 105, 283, 284, 290
Gladitsia 226
Glaucidium brodiei 655
—— radiatum 655
Gleadovia 799
—— banerjiana 799, 800
—— kwangtungense 799
Gleichenia linearis 766
Gleotrichia pisum 918
Glochidion neilgherense 843
Glossocardia linearifolia 291
Glossogobius giuris 326
Glyceria tonglensis 886
Glycosmis pentaphylla 371
Glyphodes bicolor 306
—— bivitralis 306
—— caesalis 306
—— canthusalis 306
—— hilaralis 306
—— indica 306
—— itysalis 306
—— laticostalis 306
—— marginata 306
—— negatalis 306
—— psittacalis 306
—— stolalis 306
—— unionalis 306
—— vertumnalis 306
Glyricidia 157
Gnaphalium indicum 146
—— luteo-album 376, 881
—— pulvinatum 376
Gnorimoschema operculella 609
Gomphrena ficoidea 477
—— polygonoides 477
Goniohellenus 423
Goniosoma 419, 526
—— annulatum 420
—— crucifera 419
—— cruciferum 419
—— luciferum 420
—— orientale 422
—— variegatum *v.* callianassa 421
Gonodactylus 696
Gossypium herbaceum 587
Gracilea royaleana 102
Grammica 709

PAGE

Gangea maderaspatana 146
Grantia 56
Graphium agamemnon 216
———— nomius nomius 215
Grapsus 515
————-- (Pachysoma) quadratus 520
————-- strigosus 515, 529, 531, 537, 543
Graucalus javensis 638
Grevillea 641, 643
Grewia oppositifolia 94, 370
———-- populifolia 287, 299
Gryllotalpa africana 583
Gryllus viator 588
Guazuma tomentosa 94
Gyamopsis psoralioides 602
Gygis alba monte 924
Gymnarchus niloticus 229
Gymnorhis xanthocollis 644
Gymnosporia falconeri 796, 797
———— ————-- *v.* kanjilalii 797
———— montana 92, 93, 284, 285, 286, 288
Gynandropsis pentaphylla 141, 287
Gypaetus barbatus 656
Gyps fulvus 655
——- himalayensis 655
Gysekia pharnaceoides 299
Habenaria panchganiensis 478
———— variabilis 478
(Haberaria=) Habenaria marginata 384
Hackelochloa granularis 679
Halcyon pileata 262
———-- smyrnensis 651
———-- ————-- fusca 329
Halenchus 89
———— fucicola 89
———— mediterraneus 89
———— mexicanus 89
———— zosterae 89
Halenia elliptica 882
[Haliaetus=] Haliaeetus leucogaster 979
Haliastur indus 656
———— ——-- indus 328
Halicephalobus 88
————-- limuli 88
Halpe arcuata 214
——-- homolea 214
——-- knyvetti 214
——-- kumara 214
——-- porus 214, 784
——-- sikkima 214
——-- wantona 214
——-- zema 214
——-- ——-- zema 783
——-- zola zola 783
Haltica caerulescens 609
Hamamelis 226
Hamelia patens 648
Hamiltonia suaveolens 375
Haminoea galba 701
Hantzschia 845
Harpodon nehereus 714, 715
Hasora anura 213
———-- badra 213
Hasora badra badra 782
———-- chromus 213
———-- taminatus 213
Hebomoia glaucippe glaucippe ... 778
Heise convolvuli 620
Helianthus annus 960
Helicrisum bracteatum 841
(Heliothes=) Heliothis
Heliothis 606
———— obsoleta 601, 611
Heliotropium 93, 105, 298
————- eichwaldii 292
————- indicum 98, 147, 292, 299
————- marifolium 98
————- ovalifolium 98
————- subulatum 98, 286
————- undulatum 292, 299
————- zeylanicum 292, 298
Hemicarex hookeri 885
Hemidactylus brooki parvimaculatus 327
———— frenatus 326
———— leschenaulti 327
———— triedrus triedrus ... 326
Hemiechinus auritus collaris ... 236
Hemipus picatus capitalis 637
Hemirhamphus far 325
————-- gaimardi 325
————-- xanthopterus ... 324
Hemithea costipunctata 154
Herculia ignifluālis 304
———-- nigrivitta 304
———-- suffusalis 304
———-- tenuis 304
Herdmania 705
Herminium angustifolium 384
Herpestes auropunctatus 941
———-- flavidens maccarthiae ... 330
Herpestis monniera 148
Heterocephalus glaber 452
Heterographella bengalella 303
Heterometrus 854
———— scaber ... 128, 134, 138, 139, 169, 853, 854, 855
Heteropanope 436
————-- laevis 436, 528, 535
Heteroplax dentatus 437
Heteropogon contortus 675, 677
————-- oliganthus 678
Hibiscus angulosus 837
———-- cannabinus 591, 592, 626
———-- esculentus 209, 608, 626
———-- micranthus 94
Hierococcyx varius 653
Hieroglyphus banian 583, 584, 595
————- nigrorepletus 598
Hilsa kanagurta 950
Hippolais scita 768
Hippolysmata 696
Hiptage benghalensis 370
———— madablota 370
Hirundo daurica 646
———-- fluvicola 646
———-- nipalensis 646
———-- smithii 645

PAGE

Hispa armigera ... 595, 596
Holarrhena antidysenterica ... 160
Holcocera ... 899, 900, 901
———— pulverea ... 887, 890, 891, 897, 901
Holoptelea ... 286, 295
———— integrifolia ... 285, 295, 299
Holothuria pardalis ... 704
Homo ... 935
Homochlamys pallidus ... 640
Hoplopterus duvaucelli ... 660
Huphina nerissa dapha ... 778
Hyalomma excavatum ... 469
———— marginatum ... 469
Hyarotis microstictum ... 214
Hyas ... 697
Hyastenus ... 411
———— planasius ... 411, 525, 533
Hydrocotyle asiatica ... 145
———— conferta ... 840
Hydnocarpus kurzii ... 161
Hydrodictyon reticulatum ... 909
Hydroctena ... 693
Hydroprogne caspia caspia ... 328
———— tschegrava ... 924
Hydrorybina bicolor ... 304
Hygrophila quadrivalvis ... 710
———— spinosa ... 148
Hymenoptychis sordida ... 304
Hypacanthis spinoides ... 644
Hypera variabilis ... 602
Hyperaspis maindroni ... 158
———— ———— *v.* brumoides 158
Hypericum cernuum ... 370
———— elodeoides ... 370, 878
———— hookerianum ... 836
———— mysorense ... 836
Hyperythra lutea ... 155
Hypochaeris glabra ... 841
Hypogynium ... 858, 860
———— foveolatus ... 860, 862
Hypolimnas bolina ... 780
———— misippus ... 780
Hypolycaena erylus himaventus ... 782
Hyposidra talaca ... 155
Hypsipyla robusta ... 303
Hypsopygia mauritialis ... 303
Iambrix salsala ... 214
———— ———— salsala ... 783
Icaria ... 32, 33
———— ferruginea ... 32, 33
———— marginata ... 32
———— variegata ... 33
Icerya purchasi ... 156
Ichnocarpus frutescens ... 378
Idiocerus ... 618
———— atkinsoni ... 618
———— clypealis ... 618
Ikedella ... 201, 691
———— misakiensis ... 201, 202, 695, 705
Ilex dipyrena ... 365, 371
Impatiens bicolor ... 371
———— oalsamina ... 960
———— roylei ... 879
———— scabrida ... 371

PAGE

Impatiens sulcata ... 371
Imperata cylindrica *v.* koenigii ... 676
Indicapus sylvaticus ... 769
Indigofera ... 105, 223, 283, 298
———— argentea ... 105, 286, 288, 299
———— cordifolia ... 105, 288, 711
———— dosua ... 372
———— enneaphylla ... 288, 298
———— gerardiana ... 372
———— linifolia ... 95, 288
———— oreophila ... 221, 222, 224
———— pentaphylla ... 289, 299
———— pulchella ... 372
———— subulata ... 95
———— tinctoria ... 288
———— trigonelloides ... 95
———— triquetra ... 289, 298
———— trita ... 222, 223, 224
———— wightii ... 289, 298
Indophaea cardinalis ... 957
Indoplanorbis exustus ... 254
Indoxenos ... 160, 163
———— membraciphaga ... 163
Inga dulcis ... 162
Inula cappa ... 376
———— grandiflora ... 376
Ionidium suffruticosum ... 141
Iphione ... 694
(Ipomea=) Ipomoea
Ipomoea ... 910, 911
———— batata ... 609
———— biloba ... 711
———— calycina ... 798, 799
———— pestrigridis ... 293
———— quamoclit ... 98
———— tropica ... 798, 799
———— turpethum ... 293, 300
———— vitifolia ... 293, 298, 300
Isachne angladei ... 683
———— dispar ... 683
———— kunthiana *v.* latifolia ... 683
Ischaemum aristatum ... 676
———— commutatum ... 676
———— rugosum ... 676
———— timorense ... 676
Ischnurus ochropus ... 138
Iseilema laxum ... 678
———— prostratum ... 678
Isocentris filalis ... 307
Isometrus ... 138
Ixias pyrene latifasciata ... 778
Ixobrychus cinnamomeus ... 237
———— sinensis ... 237
Ixodes kerri ... 239
Ixora ... 153
Jynx torquilla ... 649
Jacaranda ... 91
———— mimosaefolia ... 99
———— ovalifolia ... 99
Jamides alecto eurysaces ... 782
———— bochus bochus ... 781
———— celeno celeno ... 781
———— kankena pseudelphis ... 782

PAGE
Jatropha curcos ... 143
Juaravia pallidula ... 158
——— soror ... 158
Juglans regia ... 617
Juncus sphacelatus ... 885
Juniperus wallichiana ... 385
Justicia adhatoda ... 104
——— heterocarpa ... 293, 299, 300
——— procumbens ... 293, 298
——— simplex ... 293
Kasi ... 309, 315, 316, 318, 320
——— johnii ... 314
——— senex ... 314, 315
——— ——— monticola ... 314
——— ——— nestor ... 319
——— ——— senex ... 316
Kallima phillarctus horsfieldii ... 215
Kalopanax ... 226
Kalotermes beesoni ... 792, 793
Khuranti ... 951
Kigelia pinnata ... 99
Kirchneriella obesa ... 909
Kirganelia reticulata ... 711
Kochia indica ... 104
Koeleria cristata ... 885
Koruthaialos butleri ... 214
——— rubecula ... 214
Labeo bata ... 833
——— calbasu ... 833
——— rohita ... 197, 833
Lachnosterna longipennis ... 616
Lactuca brunoniana ... 377
——— lessertiana ... 377
——— violaefolia ... 366, 377
Lagenandra ... 967, 968, 969
——— meeboldii ... 967, 968, 969
——— ovata ... 967, 968, 969
——— toxicaria ... 967, 968, 969
Lagenaria vulgaris ... 119, 290, 626
Lagerstroemia indica ... 153, 155
——— lanceolata ... 963
Lalage melaschista ... 638
Lambrus ... 415
——— (Platylambrus) prensor 415, 526, 533
——— prensor ... 415
Lamellidens ... 254
——— marginalis ... 254
Lampides boeticus ... 781
Lanius schach ... 637, 890, 901, 903
——— vittatus ... 637
Lantana camara *v.* aculeata ... 149
——— indica ... 104, 380
Laphygma exigua ... 588, 599, 602
Larus brunneicephalus ... 328
——— ichthyaetus ... 328
Laternula ... 703
——— labiata ... 703
Lathraea squamaria ... 293, 298, 300
Laurrea ... 93, 105
——— nudicaulis ... 291, 299
——— pinnatifida ... 97, 291, 300
Lawsonia alba ... 711
Leersia hexandra ... 688

PAGE
Lemna ... 286, 298
——— trisulca ... 296, 300
Leonotis nepetaefolia ... 104
Leontopodium alpinum ... 376
Lepidagathis ... 711
Lepidium ruderala ... 369
Lepidocephalichthys thermalis ... 325
Lepidocephalus guntea ... 951
Leptadenia ... 713
——— reticulata ... 960
——— spartium 93, 105, 283, 284, 292, 299, 814
Leptocentrus substitutus ... 959
——— taurus ... 958, 959, 960
Leptochloa chinensis ... 685
——— obtusiflora ... 685
——— uniflora ... 685
Leptocorisa varicornis ... 470, 597
Leptodermis lanceolata ... 375
Leptodius ... 428, 527
——— crassimanus ... 429, 527, 535
——— euglyptus ... 429, 430
——— ——— quadrispinosus 429, 527
——— exaratus ... 428, 527, 535
Lepthodius exaratus ... 428
Leptoptilos cruminiferus ... 824
Leptosia nina nina ... 778
Lepyrodes geometralis ... 306
——— neptis ... 306
Lespedeza stenocarpa ... 372
Lestodryinus ... 746, 747, 749
——— pyrillae ... 741, 749
Lethe europa niladana ... 779
——— rohria rohria ... 779
Leucas aspera ... 149, 294, 299
——— cephalotes ... 883
——— ciliata ... 294, 298, 300
——— hyssopifolia ... 381
——— lanata ... 381, 883
——— urticaefolia ... 99, 294, 299, 712
——— (urticifolia=) urticaefolia
——— vestita ... 842
Leucinodes apicalis ... 307
——— (orbanalis=) orbonalis
——— orbonalis ... 307, 607
Leucopolius alexandrinus ... 660
Leucosia ... 406, 525
——— pubescens ... 406, 525, 532, 542
——— sima ... 407, 525, 532
Leucotermes ... 205
Liacos analis ... 24
Ligia ... 696
Liminitis procris procris ... 780
Limulus ... 88
Linaria cabulica ... 293, 299, 300
——— minor ... 98
Lindenbergia indica ... 379
——— ruderlis ... 379
——— urticaefolia ... 293, 298
Lingula ... 691, 692
——— anatima ... 605, 705
Lippia geminata ... 925, 926
——— nodiflora ... 380
——— unica ... 925, 926, 927

PAGE

Liquidambar 226
Liris aurata 26
Lissemys punctata ceylonensis ... 326
Lithodomus 701
———— lithophaga 701
Litocheira 438
———— angustifrons ... 438 527, 536
———— setosa ... ... 439' 527, 536
Littorina 699
Liza dussumieri 325
—— oligolepis 325
Lobipes lobatus 190, 465, 497
Lobipluvia malabarica 328, 660
Lobivanellus indicus 660
Lobocla liliana 213
Lochnera pusilla 97, 292, 299
Lonchura malabarica 330, 498
Lophactaea cristata 427
Lophomachia picturata 154
Lophophanes melanolophus ... 629
Lophoxanthus 427
Loranthus longiflorus ... 295, 298, 300
———— neelgherrensis 843
———— pulverulentus 649
———— vestitus 383
Loris tardigradus 387, 398
Lotongus sarala 214
Loxura atymnus continentalis ... 782
Lucifer 696
Luffa 119
—— acutangula 290
—— aegyptiaca 290, 626
Lupa pelagica 418
—— sanguinolenta 417
Lutjanus russelli 952
Lycium (europaeum=) europeum
——— europeum ... 93, 98, 105, 292, 299
Lycaenesthes emolus emolus ... 781
———— lycaenina lycambes ... 781
Lycaenopsis 441
Lycaugesia longipalpis ... 954, 955, 956
Lycodon aulicus 327, 949
Lycopersicum esculentum 610
Lygropia amyntusalis 306
———— quaternalis 306
Lymantria obfuscata 614
Lysimachia alternifolia 882
Lytta tenuicollis 599
Mabra eryxalis 304
Mabuya carinata 327
Macaca mulatta 171, 237
——— radiata 236
Macalla carbonifera 303
Macaria fasciata 155
——— frugaliata 155
Machaerota noctua 980
Macrones gutio 325
Macronyx strigosus 805
Macrophthalmi 512
Macrophthalmus 507, 512
———— crinitus ... 515, 529, 537
———— depressus ... 514, 529, 537
———— latreillei ... 513, 529, 537
———— pacificus ... 514, 529, 537

PAGE

Macrophthalmus pectinipes ... 512, 529, 537
———— simplicipes ... 512
———— sulcatus ... 513, 529, 537
Mactra 703
——— cornea 703
Maesa perrottetiana 841
Maja (Dione) affinis 414
Malacosoma indica 613
Malva parviflora 591, 626
Malvastrum tricuspidatum 287, 299, 591, 626
Mangifera 668
———— indica 346, 963
Manisuris myurus 679
Marasmia trapezalis 305
———— trebiusalis 305
———— venilialis 305
Margaronia 470
———— indica ... 118, 127, 470, 981
Marsilea 550, 551, 554, 567
——— aegyptiaca 550, 551, 554, 556, 557, 558, 561, 562, 563, 564, 567
——— ballardii 559, 563
——— brachycarpa 554, 565
——— (brachycharpa=) brachycarpa
——— brachypus 554, 566
——— coromandelica 554, 566
——— gracilenta 554, 566
——— minuta ... 550, 551, 554, 567
——— ——— erosa 560
——— ——— major 556
——— poonensis 562
——— quadrifolia ... 554, 557, 558, 560, 562, 563, 564
——— quadrifoliata 555, 560
——— strigosa 562
——— vestita 551, 561
Martesia 351
Martynia diandra 104
Maruca testulatis 307
Matapa aria 214, 783
——— cresta 214
——— druna 214
——— purpurascens 214
——— savisarna 214
Matuta 405, 543, 696
——— flagra 406
——— lunaris 405, 406, 524, 532, 542
——— planipes 406, 524, 532
——— victor 405
——— victrix 405
Meandria 694
Meconopsis aculeata 367, 369
———— baileyi 755
Medaeus 428, 430
———— granulosus 430, 527, 535
Medicago denticulata... 626
———— sativa 602, 626
Megachile 33, 34
———— albifrons 34
———— cephalotes 34
———— disjuncta 33, 34
———— lanata 34
Megalaima asiatica 650

Page

Megalaima haemacephala 462, 650, 890, 901, 905
———— virens marshallorum ... 649
———— zeylanica ... 650
———— ———— zeylanica ... 329
———— (zeylanicus=) zeylanica
Megalaspis cordyla ... 951
Mehraorchis ranarum ... 468, 469
Melanitis leda ismene ... 779
Melanocenchris royleana ... 102
Melanochelys trijuga ... 326
Melhania tomentosa ... 286, 287, 298
Melia ... 91
——— azedarach ... 288
——— composita ... 346
Melilotus alba ... 289, 626
Meliosma wightii ... 843
Melipona iridipennis ... 36
Melolontha fucicauda ... 616
Melophorus inflatus ... 488
Melophus lathami ... 645
Membranipora ... 705
Menaethius ... 410
———— monoceros ... 410, 525, 533
Menippe (Myomenippe) granulosa ... 433
Menochilus 6-maculatus ... 156, 159
Mentha sylvestris ... 381
Merismopedia punctata ... 917
Mermis indica ... 796
Merops orientalis ... 650
——— ——— ceylonicus ... 329
——— philippinus philippinus ... 329
——— superciliosus ... 651
Merremia hastata ... 293
———— pentaphylla ... 98
Metapeneus ... 715
Metaplax ... 522, 530, 543
———— distincta ... 523, 530, 538
———— distinctus ... 523
———— indica ... 644
Metopograpsus ... 516, 529
———— maculatus ... 517, 529, 538
———— messor 516, 517, 529, 537
Micrasterias americana ... 916
Microcerotermes ... 205
Microhyla ornata ... 326
———— rubra ... 326, 332
———— zeylanica ... 753
Microloxia ... 514
Micromeria biflora ... 381
Micronia aculeata ... 153
Micropes excavatus ... 585
Micropus affinis ... 652
———— melba ... 652
Microsarcops cinereus ... 660
Microscelis psaroides ... 631
Microtermes ... 205, 792, 793
———— heimi ... 205
———— mycophagus ... 793
———— obesi ... 205, 583
Microtricha cotesi ... 616
Microtus brandti ... 482
Millingtonia hortensis ... 99
Milvus migrans ... 656

Page

Milvus milvus lineatus ... 656
Mimastra cyanea ... 614, 616
Mimosa hamata ... 92, 96, 289, 298
———— himalayensis ... 96
———— pudica ... 144
———— rubicaulis ... 96
Mimusops hexandra ... 97
Mino dumontii kreffti ... 579
Mithrax aculeatus ... 413
Moghania praecox ... 225
———— ———— v. robusta ... 224
———— vestita ... 372
Mollugo ... 93, 105
———— cerviana ... 284, 290
———— hirta ... 284, 285, 290
———— nudicaulis ... 284, 290
———— spergula ... 96, 142
Molpastes cafer ... 631, 890, 901, 903, 905
———— leucogenys ... 631
———— ———— leucotis ... 631
Momordica balsamina ... 96, 290
———— charantia ... 119, 290, 626
———— dioica ... 290
Monogyna ... 709
Monogynella ... 709
Monophlebus stebbingi ... 619
Monotheca buxifolia ... 73
Monsonia senegalensis ... 103
Monticola cinchlorhyncha ... 634
———— solitaria ... 634
Mooreana trichoneura ... 214
Morina longifolia ... 366, 375, 880
Morinda tinctoria ... 960
Moringa oleifera ... 371
Morus alba ... 295, 844
——— indica ... 844
——— nigra ... 844
Motacilla alba ... 646, 752
———— cinerea ... 646
———— citreola ... 647
———— flava ... 647, 752
———— ——— beema ... 647
———— maderaspatensis ... 646
Mucialla rufivena ... 302
Muehlenbeckia platyclados ... 100
Mugil speigleri ... 325
Mulleripicus pulverulentus ... 462
Munia maja ... 580
Muraena (Gymnothorax) favaginea 736, 737
———— (————) ———— favaginea ... 733
———— (————) meleagris 733, 736
———— (————) picta ... 733, 736
———— (————) pseudothyrsoidea ... 733, 737
———— (————) undulata v. undulata ... 733
———— (————) ———— undulata ... 737
———— macrura ... 735
———— meleagris ... 736
———— picta ... 736
———— tesselata ... 737
Muraenesox ... 735

PAGE
Muraenesox cinereus ... 733, 734, 735
———— talabonoides ... 733, 734, 735
Muraenichthys gymnopterus ... 732, 733
———— schultzi 733
———— vermicularis 733
Murex 700
——- tribulus 700
Murraya koenigii 371, 937
Musa sapientum 101
Muscicapa parva 635
———-- strophiata 635
Muscicapula rubeculoides 636
———— superciliaris 636
———— tricolor 635
Mutilla argenteomaculata 22
——-- emeryi 22
——-- nobilis 22, 23
——-- pulchiventris 22
——-- valida 22
Mya 351
Mycalesis mineus mineus 779
———-- perseus blasius 779
Myelois pectinicornella 303
Mylabris 601, 606
———- macilenta 621
———- phalerata 608
———- tiplensis 608
Myllocerus 598
————- blandus 588
————- maculosus 588
Myomenippe 432
————-- hardwickii 432, 433, 528, 535
————-- granulosa 432
Myophoneus caeruleus 635
Myosotis sylvatica 379
Myrica nagi 365, 384
Myristica 669, 670
Myzus brassicae 593
Nacaduba dubiosa sivoka 782
———— nora nora 782
Nacobia diemenalis 305
(Naia=) Naja
Naja bungarus 257
——- hannah 272
——-naja naja 327
——- tripudians 257, 947
Nanophrys 752
Nardostachys jatamansi 880
Nasalis 309, 315, 316, 318, 320
——-- larvatus 315, 316
Nassarius 700
———-- olivacea 700
Nasturtium officinale 369
Nausitora 345
Nectarinia asiatica 943
———— ————- asiatica 330
———— zeylonica 330
Neobankia 345
Neolitsea 842
———— zeylanica 842, 843
Nemoria indecretata 154
Neophron percnopterus 655
Neopithecops zalmora 781
Neotermes gardeneri 238
Nepeta graciliflora 381

PAGE
Nepeta spicata 365, 381
Nephelium litchi 153
Nephila maculata 981
Nephopteryx leucophaeella 303
————-- paurosema 303
Nephus regularis 157
Neptis 778, 780
——- columella ophiana 780
——- hordonia hordonia 780
——- hylas adara 780
——- jumbah 215
——- ———- jumbah 780
Neptunus 417, 423, 526, 697
————-- (Neptunus) pelagicus ... 418, 526, 533, 542
————-- pelagicus 418
————-- (Neptunus) sanguinolentus 417, 418, 419, 526, 533
————-- sanguinolentus 417
Nerita 698
——- albicilla 698
——- oryzarum 698
Neritina 698
———-- crepidularia 698
Nerium 713
Nettion crecca 662
Neuracanthus sphaerostachyus ... 969
Nezara viridula 609
Nicotiana plumbaginifolia 147
————- tabacum 594
Niltava 636
——-- macgrigoriae 636
——-- sundara 636
Ninox scutulata 655
Nomia westwoodii 33
Noorda blitealis 307
——- fessalis 307
Nothosaerua brachiata ... 99, 294, 299
Notocrypta curvifascia 214
———— feisthethami 214
———— paralysos 214
Notogonia jaculatrix 957
————-- subtessellata 26
Nyctibatrachus humayuni 237
Nycticorax nycticorax 662
————- ———— nycticorax ... 328
Nymphaea stellata 93
Nymphula affinialis 304
————-- crisonalis 304
————-- depunctalis 304
————-- fluctuosalis 304
————-- foedalis 304
————-- responsalis 304
Ochlandra travancorica 689
Ochlodes brahma 214
———— siva 214
———— subhyalina 214
Ochotona rufescens 455
————- ———— vulturna ... 455
Ochus subvittatus 214
Ocimum basilicum ... 99, 149, 294, 298, 710
——-- canum 99, 294, 960
(Ocimun=) Ocimum
Octopus 703
Ocypoda 506, 507, 528, 543

PAGE

Ocypoda ceratophthalma ... 528, 536, 543
——— cordimana 507, 528, 536
——— rotundata 508, 528, 536
Ocypode albicans 89
——— ceratophthalma 506
——— (Ocypode) cordimana ... 507
——— cordimana 507
——— cordimanus 507
Odontoptilum angulata 214
——— ——— angulata ... 783
Odontotermes 204, 206, 792, 793
——— dehraduni 793
——— heimi 205
——— horni 205
——— obesus 204, 457
——— obscuriceps 205
——— redemanni 203, 204
Odynerus 32
——— miniatus 32
——— ovalis 32
Oedogonium 908, 909, 910, 912
——— hians 911
——— lautumnarium ... 910
——— rufescens 911
Oenanthe picata 632
Oenopopelia tranquebarica 658
Oenothera odorata 839
——— rosea 374, 839
Oldenlandia 105
——— brachiata ... 96, 291, 298, 300
——— corymbosa 96, 145, 286, 291, 300, 375
——— gracilis 375
——— umbellata ... 291, 298, 300
Oligodon arnensis albiventer ... 327
Oligostigma bilineale 304
——— picale 304
Oliva lepida 701
——— nebulosa 701
Omphisa anastomosalis 307
Oncidium 701
Ooencertus paplionus 747
Ophibolus getuleus 948
Ophicephalus 826
——— striatus 833
Ophichthys 199
——— apicalis ... 199, 732, 733, 939
——— cephalozona 732, 733, 738, 739
Ophisurus serpens 199
Opisthophthalmus 854
——— latimanus typicus 853
Oplismenus compositus 681
Opuntia dillenii 290
Oriens ada 214
——— goloides 214
Origanum vulgare 381, 883
Oriolus kundoo 641
——— oriolus 890, 903
——— traillii 641
——— xanthornus 641
Ornithospila 154
Oropetium thomaeum 687
Orsonoba clelia 155
Orsotrioena medus medus 779
Orthaga euadrusalis 303

PAGE

Orthetrum 210
Orthochirus innesi 132
Orthotomus sutorius 639
——— ——— sutorius ... 329
Oryctes rhinoceros 388
Orygia decumbens 93, 96
Oryza meyeriana 688
——— sativa 595, 688
Osbeckia stellata 374
Oscillatoria brevis 917
——— granulata 917
——— lacustris 917
——— quadripunctulata ... 917
——— tereberiformis 917
Osicerda 155
Otinotus oneratus ... 160, 163, 958, 960, 981
——— pallescens 163
Otocompsa emeria 190
——— flaviventris 632
Otus sunia 654
Oxalis corniculata 370
——— latifolia 370
——— pubescens 837
Oxya 595
Oxybelus agilis 31
Oxycaraenus loetus 590, 608
Oxyrhachis tarandus 959, 960
Oxyria digyna 382
Oxytenanthera monadelpha 689
Ozius 433
——— rugulosus ... 433, 528, 535, 542
Ozola microniaria 153
Pachidiplosis oryzae 238
Pachynoa pectinicornalis 307
——— sabelialis 307
Pachyzancla aegrotalis 307
——— licarsisalis 307
——— phoeopteralis 307
Pagyda traducalis 305
Palamnaeus 138
Palmipis 704
Pamphlebia 154
Pandanus 101, 470, 664
——— tectorius 671, 954
Pandinus 130
——— imperator 131
Pandorina morum 908
Panicum adscendens 102, 296
——— antidotale 297, 299, 681
——— colonum 102
——— maximum 681
——— montanum 682
——— paludosum 681
——— psilopodium 681
——— ramosum 102, 297
——— repens 675, 682
——— stagninum 102
——— subeglume 682
Panicum turgidum ... 93, 105, 283, 297
——— trypheron 675, 681
Pantala 210, 211
Panthera leo 171, 173, 450, 568, 576
——— tigris 171, 452, 454
Pantoporia perius 214, 780
Panulirus 696

PAGE

Paphia ... 703
——— malabarica ... 505, 522, 703
——— textile ... 703
——— undulata ... 703
Papilio demoleus ... 216, 217, 621
——— ——— demoleus ... 777
——— memmnon agenor ... 777
——— polytes ... 216
——— ——— romulus ... 777
Parabonellia ... 201
——— misakiensis ... 202
Paracanthonchus caecus ... 89
Paraechinus micropus micropus ... 236
Paramithrax ... 413
——— (Chlorinoides) aculeatus 413, 525, 533, 542
Parasa ... 616
——— lepida ... 238
(Paratetranchus =) Paratetranychus
Paratetranychus indicus ... 157, 599
Pareronia valeria hippia ... 778
Parevaspis carbonaria ... 34
Parkinsonia ... 713
Parnara ganga ... 214
——— guttatus ... 214, 783
——— naso ... 214
Parnassia nubicola ... 367, 373, 879
Parnassius epaphus sikkimensis ... 755
Paroaria cucullata ... 578
Parreysia favidens ... 254
Parthenium hysterophorus ... 218, 219
Parthenos sylvia gambrisius ... 780
Parus major ambiguus ... 979
——— ——— caschmeriensis ... 629
——— monticola ... 629
Paspalidium flavidum ... 675, 680
——— geminatum ... 681
Paspalum conjugatum ... 680
——— orbiculare ... 680
——— sanguinale ... 102
——— ——— cruciatum ... 886
——— scrobiculatum ... 680
Passer domesticus ... 644, 890, 901, 903
——— ——— soror ... 330
——— montanus ... 578
——— rutilans ... 644
Passiflora calcarate ... 840
——— coerulea ... 374
——— edulis ... 840
——— leschenaultii ... 840
Patella radiata ... 698
Pavo cristatus ... 464, 659
Pavonia zeylanica ... 287, 298
Pecten singaporina ... 702
Pedalium murex ... 99, 105, 293, 299
Pediastrum tetras ... 909
Pedicularis carnosa ... 380
——— gracilis ... 882
——— pectinata ... 380, 883
——— ——— palans ... 883
——— siphonantha ... 380
Pelecanus ... 191
Pelecypoda ... 701
Pellorneum ruficeps ... 630
Pelopidas agna ... 214

Pelopidas agna agina ... 784
——— assamensis ... 214
——— conjuncta ... 214
——— sinensis ... 214
Penaeus ... 696, 715
(Peneus =) Penaeus
Penium libulata ... 914
Pennisetum ... 814
——— hohenackeri ... 683
——— typhoides ... 626, 683
——— typhoideum ... 293, 297, 599
Peperomia reflexa ... 365, 382
Perdicula asiatica ... 659
Periclimnus ... 696
——— brevecarpalis ... 696
Pericrocotus brevirostris ... 638
——— peregrinus ... 638, 890, 904
——— ——— ceylonensis 329
——— roseus ... 638
——— speciosus ... 638
Periopthalmus ... 705
Peristrophe ... 713
——— bicalyculata 99, 282, 286, 293, 299
Perotis indica ... 675, 685
Pharoscymnus guimeti ... 159
——— horni ... 158, 159
Phaseolus aconitifolius ... 289
——— mungo ... 156
——— ——— roxburghii ... 626
——— ——— radiatus ... 289, 601, 626
——— pauciflorus ... 95
——— semierectus ... 95
——— vulgaris ... 289
Phenacoccus insolitus ... 156
Philanthus ... 30
——— basalis ... 30
Philomachus pugnax ... 464
Philyra ... 407, 525
——— corallicola ... 408, 525, 532
——— globosa ... 407, 525, 532
Phleum alpinum ... 885
Phlomis bracteosa ... 883
Phlyctaenodes massalis ... 307
Phoenicoparrus jamesi ... 169
Phoenicopterus antiquorum ... 168
——— chilensis ... 168
——— ruber ... 167, 168
Phoenicurus ochrurus ... 633
Phoenix dactylifera ... 101
——— sylvestris ... 296
Phragmites karka ... 684
Phryganodes analis ... 305
Phycita defiguralis ... 303
——— hemixanthella ... 303
——— infusella ... 589
Phyllanthus ... 962
——— emblica ... 100, 265
——— madraspatensis ... 93, 295
——— niruri ... 93, 143, 295
——— uninaria ... 143
Phyllocnistis citerella ... 621
Phyllognathopus ... 795
——— viguieri ... 793
Phylloscopus ... 768
——— affinis ... 768

PAGE
Phylloscopus collybitus 768
——— fuscatus 768
——— griseolus 768
——— inornatus 640
——— ——— humei ... 768
——— occipitalis 641
——— ——— occipitalis ... 769
——— trochiloides 768, 769
Physalis minima 286, 292
——— peruviana 292, 299
Phytomyza atricornis 601
Picea morinda 366
——— smithiana 386
Picumnus innorminatus 461
Picus canus 462
——— xanthopygeus 462
Picorrhiza kurooa 883
Pieris brassica 603, 611
——— ovalifolia 365, 378
Pilea scripta 383
——— umbrosa 383
Piliocolobus 309
Pilumnus 434, 528, 697
——— longicornis ... 435, 528, 535
——— vespertilio 434, 528, 535
Pimpinella diversifolia 880
Pingasa 153
Pinna 701
——— nigra 702
Pinnotheres 503
——— placunae 503, 528, 536, 542
——— quadratus 506
——— similis 504
——— vicajii 505, 528
Pinnularia 845, 852
——— acrosphaeria *f.* undulata... 845
——— ——— *v.* genuina *f.* undulata ... 845
Pinnularia acrosphaeria *v.* minor ... 846
——— aestuarii 851
——— ——— *v.* interrupta ... 851
——— ——— *v.* lata 851
——— angustefasciata 850
——— ——— *v.* schmidtii 850
——— braunii 848
——— *v.* amphicephala... 848
——— *v.* ——— *f.* conica ... 848
——— *v.* ——— *f.* subconica ... 848
——— brebissonii *v.* producta ... 847
——— ——— *v.* ——— *f.* biundulata ... 847
——— conica 847
——— divergens 846
——— ——— *v.* capitata ... 850
——— esox 849, 850
——— ——— *v.* capitata 849
——— ——— *v.* clevei 850
——— ——— *v.* fasciata 849
——— interrupta *f.* braunii ... 848
——— isostauron 852
——— ——— *v.* conifera ... 852
——— ——— *v.* genuina ... 852
——— karnatica 846

PAGE
Pinnularia legumen *v.* florentina ... 847
——— marginata 848
——— microstauron *f.* biundulata 847
——— ——— *v.* ambigua 847
——— neglecta *v.* interrupta ... 850
——— nodosa *v.* pseudogracillima 848
——— polyonca 850
——— regina 850
——— stauroptera *v.* longa ... 849
——— stomatophora *v.* bergii ... 846
——— stomatophoroides ... 846
——— ——— *v.* nuda 849
——— ——— *v.* ornata *f.* erlangensis 846
——— westii 851
Pinus excelsa 386
——— gerardiana 74
——— longifolia 386
——— roxburghii 365
——— ——— sargent 386
——— wallichiana 368, 386
Pionea ablactalis 308
——— albicostalis 308
——— leucanalis 308
Piper 710
Piprisoma agile 649
Pison argentatum 27
Pisoodonophis boro 733, 738
——— cancrivorus ... 732, 733, 738
Pistia stratiotes 151
Pisum sativum... 601
Pithauria murdava 214
——— stramineipennis 214
Pithecolobium dulce 161, 960
——— saman 267
Pitta brachyura 649, 890, 901
Placenta placenta 702
Placuna placenta 503, 504, 505
Plagusia 523
——— depressa *v.* squamosa ... 523
——— ——— *v.* tuberculata ... 523
——— ——— tuberculata 523, 529, 531, 538
——— squamosa 523, 524
Plantago amplexicaulis 99
——— major 381
Plastingia callineura 214
——— naga 214
Plastus 790
Platalea leucorodia 193
Platanista gangetica 270
Platycarya 226
Platydera gossypiella 591
Platylambrus 415
Platypodia 427
——— cristata 427, 527, 534
Platytes argentisparsalis 302
Plaxipora 697
Plectranthus gerardianus 380
Plectronia ficiformis 840
Plegadis falcinellus 191
Pleurospermum angelicoides... ... 880
——— candollii 880
Pleurotaenium ehrenbergii *v.* crassa 915
Ploceus philippinus 491, 502, 643, 890, 903, 979

PAGE

Ploceus philippinus philippinus ... 330
Plotosus anguillaris 324
Pluchea lanceolata 105
Plumeria acutifolia 97
Plumularia 693
Plusia nigrisigna 611
——— orichalcia 611
Plutella maculipennis 611
Pluvialis dominica fulva 328
Poa aspera 102
Podagria 608
Pogonatherum paniceum 676
Poinciana 91
——— regia 95
Poinsettia pulcherrima 101
Polistes 33
——— hebraeus 33
——— stigma 33
Pollinidium binatum 676
Polyalthia longifolia 154
Polycarpaea corymbosa 105, 141, 286, 287, 370
Polycarpon tetraphyllum 836
Polydactylus indicus 199, 200, 201
Polydorus aristolochia 216
——— hector 333
Polygala 240
——— abyssinica 93, 105, 287, 299, 365, 369
——— chinensis 369
——— crotalarioides 369
——— erioptera 93, 105, 283, 284, 287, 299, 369
——— persicariaefolia 369
——— ramaswamiana 240
——— tatarinowii 369
Polygonum 710
——— affine 367, 382, 884
——— alatum 884
——— amplexicaule 382, 884
——— capitatum 366, 382
——— chinense 713
——— donii 382
——— plebejum 150, 284, 285, 295, 298, 382
——— polystachyum ... 367, 382, 884
——— vaccinifolium ... 367, 382, 884
——— viviparum 382
Polynemus 725
Polynoe 694
Polypogon monspeliensis 385
Polytremis discreta 215
——— eltoca 215
——— lubricans 215
Pomadasys 199, 200
Pomaderris lanigera 837
Pomatorhinus erythrogenys 630
——— ——— ferrugilatus 767
——— schisticeps 630
Pompilus fenestratus 25
——— mitis 25
Pongamia 158
——— glabra 303
Porites 694
Portulaca grandiflora 94
——— oleracea 141, 142, 287
——— quadrifida 142, 287

PAGE

Portunus (Oceanus) crucifer ... 419
——— (———) dentatus ... 420
——— (Neptunus) pelagicus ... 418
——— (Portunus) pelagicus ... 418
——— pelagicus 418
——— (Thalamita) prymna ... 424
——— (Neptunus) sanguinolentus 417
——— (Portunus) sanguinolentus 417
——— sanguinolentus 417
Potamides 699
Potanthus confucius 214
——— ganda 214
——— juno 214
——— lydia 214
——— nesta 214
——— pallida 214
——— palnia 214
——— pseudomaesa 214
——— rectifasciata 214
——— sita 214
——— trachala 214
——— trachala tytleri 783
Potentilla 366
——— argyrophylla ... 367, 373, 879
——— ——— v. atrosanguinea 373
——— fruticosa 373
——— fulgens 373, 879
——— microphylla 879
Pouzolzia hirta 384
——— pentandra 384
——— viminea 384
Pratapa deva 214
Precis almana almana 781
——— atlites 781
——— hierta hierta 780
——— hierta magna 780
——— iphita iphita 781
——— lemonias lemonias 780
——— orithiya ocyale 780
Presbytis 309, 316, 318, 319, 320
——— everetti 315
——— femoralis 315, 316
——— ——— chrysomelas ... 315
——— frontatus 315
——— hosei 315
——— melalophos 315, 318
——— rubicundus 315
——— thomasi 316, 318
Primula 882
——— floribunda 378
——— involucrata 882
——— macrophylla v. macrocarpa 882
Prinia inornata 640
——— ——— insularis 329
——— socialis 640
——— sylvatica 640
Prinsepia utilis 372
Priochirus 790
——— (Plastus) astoliensis ... 790
——— (———) maitrta 791
Prionia squalidaria 155
Pristipoma argenteum 951
Procapra gutturosa 484, 486
Procolobus ... 309, 311, 316, 318, 319, 320
——— (Piliocolobus) badius ... 312

PAGE
Procolobus (Piliocolobus) badius
waldroni 318
——— badius 316, 318
——— ——— badius 312
——— badius waldroni ... 311, 316
——— verus 313, 315, 316
Prodenia litura 592, 594, 612
Prosopis 91, 286
——— spicigera 92, 283, 285, 289, 299, 962
Protosiphon botryoides 970
Prunella atrigularis 635
Prunus bokhariensis 616
Pseudagenia blanda 24
——— micromegala 24
——— tincta 24
Pseudaspidimerus circumflexa *v.*
testaceus 157
Pseudococcus 156, 157, 158
——— victoris 157
Pseudodromia 402
——— caphyraeformis ... 402
——— integrifrons ... 402, 525, 532
Pseudograpsus 519
——— intermedius 519, 530
Pseudogyps bengalensis 655
Pseudoraphis aspera 683
Pseudoterpna ruginaria 153
Psidium guava 157, 622
Psiloteredo 671
Psittacula alexandri 185
——— cyanocephala 654
——— eupatria 654
——— himalayana 654
——— krameri 654
——— ——— manillensis ... 328
Pteria vulgaris 702
Pterocles orientalis 466
——— senegallus 467
Ptochophyle permutans 154
——— togata 154
Ptyas mucosus ... 196, 327, 334, 807, 949
Pulicaria wightiana ... 93, 105, 291, 298
Pullus castaneus 156
——— gratiosus 156
——— nubilus 156
——— picescens 156
——— victoris 156
Punica granatum 379, 620, 626
Puntius 826, 827, 828, 829, 831
——— conchonius 833
——— stigma 826, 834
——— ticto 826, 834
——— vittatus 826, 834
Pupalia lappacea 93, 294, 299
Pycnarmon caberalis 304
——— ——— *f.* abdicalis ... 304
——— meritalis 304
——— virgatalis 304
Pycnonotus cafer cafer 329
——— luteolus insulata ... 329
Pygospila tyres 306
Pyralis manihotalis 303
——— pictalis 303
Pyramidula rupestris salimalii ... 239
Pyrausta incoloralis 308

PAGE
Pyrausta phoenicealis 308
Pyrene 700
Pyrilla ... 598, 741, 742, 743, 745, 747, 748, 749
——— perpusilla ... 170, 584, 741, 749
(Pyrilloxenes=) Pyrillozenos
(Pyrilloxenus=) Pyrillozenos
Pyrillozenos 749
——— compactus ... 746, 747, 749
Quadraspidiotus perniciosus ... 614
Quelea 811, 825
——— quelea 811, 825
——— ——— aethiopica 812, 822
——— ——— lathami 812
——— ——— quelea 812
——— ——— russi 812
Quercus incana 365, 366, 379, 382, 383, 384
Quisqualis indica 96
Ramila acciusalis 302
——— marginella 302
Rana breviceps ... 197, 326, 332, 333, 334
——— corrugata 753
——— cyanophlyctis 272, 326, 332, 333, 468,752
——— limnocharis greeni 753
——— (Hyalorana) temporalis ... 753
——— tigrina 468
——— ——— crassa 326, 332, 333
Ranunculus diffusus 368
Raoiella indica 157, 158
Rapala jarbas 782
——— melampus ... — ... 216
——— pheritimus petosiris 782
——— schistacea 215, 782
Rattus rattus kandianus 330
Ratufa bicolor 315
Reinwardtia trigyna 370
Rhabditis ocypodis 89
——— (Choriorhabditis) marina
v. bengalensis 87
——— marina 87, 89
Rhacophorus cruciger cruciger ... 753
——— ——— eques ... 753
——— leucomystax 332
——— ——— maculatus 326, 332, 334
——— maculatus 197
——— microtympanum ... 752
Rhagophthalmus 778, 789
Rhamphiopis rostratus 824
Rhinoceros 763
——— unicornis 763
Rhinocichla mitrata 579
——— ——— mitrata ... 579
Rhipidura albicollis 637
——— aureola 637
——— ——— compressirostris 330
Rhipiphoro-thrips cruentatus ... 620
Rhododendron arboreum 365, 378
——— campanulatum 368, 378, 385
——— lepidotum 366, 378
Rhodometra 155
Rhodophila ferrea ferrea 632
Rhopalosiphum [nympaeae=] nymphaeae
——— nymphaeae ... 156
Rhyacornis fuliginosus 633
Rhynchium 32

PAGE
Rhynchium brunneum ... 32
—— metallicum ... 32
—— nitidulum ... 32
Rhynchoglossum obliquum ... 380
Rhynchops albicollis ... 190
Rhynchosia bracteata ... 797, 798
Rhus cotinus ... 371
—— parviflora ... 368, 371, 378
Riccia ... 286
(Ricinis=) Ricinus
Ricinus communis ... 295, 592
Riopa punctata ... 327, 334
Riparia concolor ... 645
—— paludicola ... 646
—— rupestris ... 645
Rita ... 253
Rivea ornata ... 104
Rosa ... 713
—— moschata ... 373
Roscoe purpurea ... 884
Roscoea procera ... 384
Rostratula benghalensis ... 661
Rottboellia exaltata ... 679
Rousettus ... 498
Roylea elegans ... 381
Rubia cordifolia ... 880
Rubus ellipticus ... 372
Ruellia prostrata ... 293, 299
Rumex dentatus ... 100
—— hastatus ... 382
—— nepalensis ... 382
Ruscus hypophyllum ... 101
Russelia juncea ... 98, 648
Saccharicoccus sacchari ... 158, 203
Saccharum munja ... 92, 102, 105, 283, 300
—— officinarum ... 583
—— spontaneum ... 102, 296, 300, 626, 676
Saccolepis indica ... 682
—— interrupta ... 682
Sacculina ... 696
Sacellum ... 700
Sagitta ... 704
Salius ... 25, 29
—— aureosericeus ... 25
—— consanguineus ... 25
—— flavus ... 25
—— fulvipennis ... 25
—— madraspatanus ... 25, 26
Salmalia malabarica ... 370
Salvadora ... 286
—— oleoides ... 92, 285, 291, 299
—— persica ... 283, 285, 291, 299
Salvia ... 104
—— lanata ... 381
Sameodes cancellalis ... 307
Sanicula europea ... 880
Sanseviera cylindrica ... 101
Sapium insigne ... 383
—— sebiferum ... 383
Saponaria vaccaria ... 103
Sarangesa dasahara ... 214, 216
—— —— dasahara ... 783
Sarcococca pruniformis ... 383
Sarcogyps calvus ... 655

PAGE
Saroglossa spiloptera ... 641
Satarupa gopala ... 214
Satyrium nepalense ... 384, 884
Saussurea ... 367
—— albescens ... 377
—— denticulata ... 377
—— gossypiphora ... 377, 881
—— hypoleuca ... 377, 881
—— kunthiana ... 881
—— lappa ... 73, 881
—— obvallata ... 366, 377, 881
—— piptathera ... 377
—— taraxicifolia ... 377, 881
Saxicola caprata ... 632
—— torquata ... 632
Saxicoloides fulicata ... 634
—— —— fulicata ... 329
Saxifraga diversifolia ... 367, 373, 879
—— filicaulis ... 373
—— hirculus ... 373
—— ligulata ... 373
—— moorcroftiana ... 373
Scardamia metallaria ... 155
Scatophagus argus ... 326, 952
Sceliphron ... 28
—— coromandelicum ... 28
—— madraspatanum ... 28
—— violaceum ... 28
Scenedesmus bijugatus ... 909
Schefflera racemosa ... 843
Schizachyrium ... 858, 865
—— delavayi ... 860, 865
—— paranjpyeanum ... 861, 865
Schizophrys ... 414
—— asper ... 414
—— aspera ... 414, 525, 533
Schoenobius adjurellus ... 303
—— bipunctifer ... 303, 596
—— immeritalis ... 303
—— incertellus ... 303
Sciaena ... 725
Scirpophaga auriflua ... 302
—— bisignata ... 302
—— gilviberbis ... 302
—— nivella ... 586
Scirpus maritimus ... 296
Scobura isota ... 214
—— phiditia ... 214
Scolia aureipennis ... 23
—— bilunata ... 23
—— histrionica ... 23
—— quadripustulata ... 23
Scoparia dulcis ... 293, 299
Scopimera myctiroides ... 511
Scopula ... 154
Scorpio maurus ... 136
Scutellaria linearis ... 381
Scylla ... 416
—— serrata ... 416, 418, 526, 533, 543
Seymnus ... 157
—— guimeti ... 157
—— nubilus ... 156
—— (=Pullus) quadrillum ... 156
Sebastonyma dolopia ... 214
Sedum ewersii ... 374

PAGE

Sedum multicaule ... 374
——— trullipetalum ... 367, 374
Sehima nervosum ... 675, 676
Seicercus burkii ... 640
———— xanthoschistos ... 640
(Selinium=) Selinum
Selinum tenuifolium ... 375, 880
——— ——— v. filcifolia ... 375
Semiothisa ... 155
Semnopithecus ... 309, 314, 315, 318, 320
——— entellus ... 237, 314, 315
——— priam ... 314, 316
——— schistaceus ... 314
Senecio amplexicaulis ... 881
——— arnicoides ... 881
——— chrysanthemoides ... 881
——— nudicaulis ... 377
Sepia ... 704
Sericostoma pauciflorum ... 98, 292 ,298
Sertularia ... 693
Sesamia inferens ... 587, 597, 598
Sesamum indicum ... 293
Sesarma ... 520, 530
——— (Sesarma) minuta 522, 530, 538, 543
——— (———) oceanica... 521, 530, 538
——— oceanicum ... 520
——— (Parasesarma) plicata ... 520
——— (Sesarma) quadrata 521, 530, 538
——— quadrata ... 520
——— (Sesarma) quadratum ... 520
——— quadratum ... 520
——— (Sesarma) rotundata ... 520
——— (———) taeniolata 521, 530, 538
——— taeniolata ... 521
——— (Sesarma) taeniolatum ... 521
——— taeniolatum ... 521
Sesbania aculeata ... 161, 162
——— aegyptiaca ... 592, 626
——— grandiflora ... 161
Seseria sambara ... 214
Setaria ... 105, 710
——— glauca ... 102
——— intermedia ... 675, 683
——— italica ... 682
——— pallidifusca ... 674, 675, 682
——— palmifolia ... 682
——— verticillata ... 102, 675, 683
Sexava nubila ... 470
Shorea robusta ... 627
Sida ... 105
——— cordifolia ... 142, 284, 287, 298
——— grewioides ... 94
——— humilis ... 286, 287, 299
——— rhombifolia ... 287
——— veronicaefolia ... 103, 142, 287
Sidastrea ... 694
Siganus javus ... 325
Sillago sihama ... 325
Silonia silondia ... 951
Simarouba ... 288
Siphocoryne indorassica ... 605, 613
Siphonocladus ... 87
Sirogonium floridano ... 914
——— floridanum ... 914
——— stictum v. microsporum 914

PAGE

Sirogonium stictum v. megasporum 914
Sisymbrium irio ... 93
Sitana ponticeriana ... 327
Sitta castanea ... 630
Skimmia laureola ... 626, 879
Smilax aspera ... 385
Smithia dichotoma ... 289, 298, 300
——— sensitiva ... 285, 289, 300
Solanum ... 965
——— esuriale ... 965
——— indicum ... 292, 298, 965
——— melongena ... 238, 292, 606, 710
——— nigrum ... 148, 284, 292, 379, 882
——— seaforthanum ... 379
——— tuberosum ... 609
——— verbascifolium ... 379
——— xanthocarpum 148, 292, 299, 379
Solarium ... 699
Solen ... 703
Solen lamarckii ... 703
——— truncatus ... 703
Solenopsis geminata ... 459
Solidago virga-aurea ... 376
Somatina anthophilata ... 154
Sonchus ... 286
——— arvensis ... 291, 300
——— asper ... 97, 291, 300
——— oleraceus ... 291
Sopubia trifida ... 379
Sorex araneus ... 487
Sorghum ... 475, 814
——— (halepenae=) halepense
——— halepense ... 102, 585, 626, 677
——— (helepense=) halepense
——— nitidum ... 677
——— vulgare ... 297, 585, 598, 603, 626
Soriculus baileyi ... 755
Sovia grahami ... 214
——— lucasii magna ... 214
Spalgis epius epius ... 781
Spergula rubra ... 94
Spermacoce ... 105
——— hispida ... 145, 284, 291, 299
——— stricta ... 96, 291, 299, 375
Sphaeroma ... 964
——— terebrans ... 963
Sphenoptera ... 617
——— gossypii ... 591
Sphex ... 28, 29
——— aurulentus ... 29
——— lobatus ... 28
——— luteipennis ... 25, 29
——— splendidus ... 29
——— umbrosus ... 29
——— vicinus ? ... 29
Spialia galba ... 214
Spilanthes acmella ... 841
Spilornis cheela ... 657
Spinacia oleracea ... 626
Spindasis gabriel ... 782
——— lohita ... 216
——— ——— himalayanus ... 782
——— syama peguanus ... 782
——— vulcanus vulcanus ... 782
Spiranthes australis ... 384

PAGE
Spirogyra anomala 912
———— margaritata 912
———— nitida v. microspora ... 912
———— singularis 913
———— spreeiana v. kashiensis ... 912
Spirulina gomontii 917
Spondias mangifera 960
Sporobolus 105
———— coromandelianus ... 685
———— diander 675, 685
———— glaucifolius 102
———— indicus 885
———— orientalis 102, 297
———— piliferus 685
———— scabrifolius 685
———— spicatus 685
———— tremulus 685
———— virginicus 102
———— wallichii 685
Squilla 696
Stachys melissaefolia 381
———— sericea 883
Stachyridopsis pyrrhops 631
Stachytarpheta 713
———— indica 93, 104, 294, 298
Staurastrum clepsydra v. sibericum 916
———— dickie 916
———— dubium 916
Stemmatophora pallidella 304
Stenolobium stans 98
Stephania japonica 836
Stephanoaetus coronatus 311
Sterna albifrons 924
———— ———— sinensis 328
———— anaethetus antarctica... ... 921
———— bergii thalassina 923
———— dougallii aridensis 923
———— fuscata nubilosa 920
———— sumatrana mathewsi 923
Sterrha macrospila 155
———— sacraria 155
Stethorus 157
———— gilvifrons 157
———— parcepunctatus 157
———— pauperculus 157
———— tetranychi 157
Sticholotis 158
———— cribrellata 158
Stigeoclonium attenuatum 910
———— flagelliferum 910
———— nanum 910
Stigmus niger 30
Stilbum cyanurum 31
Stimula swinhoei 214
Stizus 30
———— blandinus 30
Stoicactis 694, 696
Stranvaesia glaucescens 373
Streblus asper 713
Streptopelia chinensis 658, 752
———— ———— ceylonensis ... 328
———— decaocto 658
———— orientalis 658
———— ———— meena ... 658
———— risoria 752

PAGE
Streptopelia senegalensis 658
Striga 105
———— lutea 293, 298, 300
Strobilanthes 713
———— dalhousianus 380
———— discolor 799, 800
Stromateus cinereus 715
Sturnia malabarica 642
Sturnopastor contra 642
Sturnus pagodarum pagodarum ... 330
———— vulgaris 578, 642
Suana concolor 784
Suastus gremius 214
———— minuta 214
Sunneta 703
———— donacina 703
Surendra quercetorum quercetorum 782
Surniculus lugubris 653
Sus scrofa cristatus 271
Swertia alternifolia 882
———— chireta 148
———— cordata 379
———— cuneata 379
———— paniculata 379
———— purpurescens... 882
Sylepta aurantiacalis 306
———— derogata 306, 588, 608
———— lunalis... 306
Sylvia curruca 639
Symplocos paniculata... 378
———— racemosa 937
———— spicata 937
Syngamia abruptalis 305
———— floridalis 305
Syntarucus plinius 216, 781
Syzygium arnottanum 839
———— cumini 373
———— montanum... 839
Tabernaemontana coronaria... ... 97, 306
Taccocua leschenaultii 653
Tachytes 26
———— modesta 26
———— nitidula 26
Tacsonia mollissima 840
Taeniura lymma 770, 773
———— melanospila ... 770, 771, 773
———— melanospilos 770
Tagiades cohaerens 214
———— gana 214
———— japetus 214
———— ———— ravi 783
———— litigiosa 214
———— menaka 214
———— parra 214
Tajuria cippus cippus 782
Talanga sexpunctalis 304
Tamarindus indica 103, 289
Tamarix articulata 285, 287, 299
———— dioica 94
Tamraca torridalis 304
Tanacetum longifolium 376, 882
———— nubigenum 373
Tarache 207
———— nitidula 207, 209
———— notabilis 207, 589

PAGE

Tarucus 441
Tatera indica ceylonica 330
Tatobotys varanesalis 304
Taxillus vestitus 383
Taxus baccata 366, 386
Tchitrea paradisi 636
Tecoma capensis 98
——— stans 98, 710
——— undulata 92, 293, 299
Tecomaria capensis 98
Tectona grandis ... 346, 667, 668, 960, 963
Tealiaf 693
Telanthera ficoidea 477
————-- polygonoides 477
Telescopium 696
———— telescopium 699
Telicota ancilla bambusae 783
——— ancilla 214
——— colon 214
——— linna 214
——— onara 214
——— ——— stinga 783
Tellina 703
——— timorensis 703
Temenuchus pagodarum 642
Temnopleura 704
Tephrina disputaria 155
Tephrodormis pondicerianus 638, 890, 901
Tephrosia 105, 711
————- purpurea ... 93, 282, 284, 285, 289
————- strigosa 805
————- tenuis 289, 298, 805
Terastia meticulosalis 307
Terebella 694
Teredo 239, 345, 666, 671, 964
——— (Zopoteredo) bengalensis ... 345, 671
——— (Teredora) clava 345
——— clava 346
——— (Teredo) furcillatus 345
——— furcillatus 346
——— (Teredora) gregoryi 345
——— gregoryi 346
——— (Teredo) indica 345, 669
——— indica 346
——— (Teredothyra) linearis ... 345
——— (Teredo) madrasensis ... 345, 668
——— madrasensis 346
——— (Kuphus) manni 963
——— (Teredora) minoris 345
——— (Teredo) navalis 345, 667
——— navalis 346, 667
——— (Teredo) parksi 345, 670
——— parksi 346
——— (Teredora) rehderi 345
——— rehderi 346
——— (Psiloteredo) tondiensis ... 672
Teredora 345
Teredothyra 345
Terias 778
——-- blanda silhetana 778
——-- hecabe hecabe 778
——-- laeta sikkima 778
——-- libythea 778
Termes 204, 613
Terminalia 346, 639, 716

PAGE

Terminalia arjuna 103
————-- paniculata 963
————-- tomentosa 963
Terminalis myriocarpa 654
Tetranychus 157
————- cucurbitae 605, 608
————- tetericus 608
Tetrastichus pyrillae 747
Tetrastigma muricatum 837
Tetridia caletoralis 307
Tetrodon 705
Teucrium quadrifarium 381
Thais 696, 700
——- carinifera 700
——- rudolphi 700
——- rugosa 700
——- sacellum 700
Thalamita 423, 425, 526
———— crenata 423, 527, 534
———— prymna ... 424, 425, 527, 534
———— ——— *v.* crenata ... 423
Thalassodes acutissima 154
————-- avicularia 154
————-- quadraria 154
————-- rubrolimbraria 154
————-- veraria 154
Thalera caudularia 154
———- chrysolineata 154
Thalictrum cultratum 368
————- javanicum 368
————- minus *v.* majus 368
————- reniforme 366, 368
————- (reniformis=) reniforme
Themeda cymbaria 678
———- quadrivalvis 678
———- tremula 678
———- triandra 678
Therapon jarbua 325
Thespesia 346
————-- populnea 94
Thevetia 158
Tholymis 210
Thoressa cerata 214
———- fusca debitis 214
Thrips indicus 602
——- tabaci 610
Thrissocles 953
Thunbergia 99
Thymus serpyllum 381
Thyrsoidea macrurus 733, 735
Thysanophrys indicus 325
Tichodroma muraria 632
Tockus birostris 651
———-- erythrorhynchus 824
Torquigener oblongus 325
Trachylepidia fructicassiella 302
Trachypithecus ... 309, 315, 318, 320
——————-- cristatus 315
——————-- ————-- pyrrhus ... 315
——————-- obscurus ... 315, 316, 318
——————-- phayrei crepusculus 315
——————-- pileatus 314
Trachys muricata 684
Tradescantia 101
Tragus biflorus 102, 675, 684

PAGE
Tramea ... 210, 211
Trapa ... 156
—— bispinosa ... 613, 626
Trialeurodes ricini ... 593
Trianthema ... 93, 105, 293, 712
—— crystallina ... 290, 299
—— hydaspica ... 96
—— monogyna ... 142, 290
—— pentandra ... 286, 290, 299
Tribulus ... 293
—— alatus ... 94, 288, 299
—— terrestris ... 93, 105, 284, 288
Tricephalobus ... 88
Trichiurus savala ... 715
Trichodesma amplexicaule ... 292, 298, 299
—— indicum ... 93
Trichopus litteratus ... 518
Trichosanthes ... 290
—— dioica ... 118, 119
Tridax procumbens ... 146, 286, 291, 299, 377
Tridgodes cuneilinea ... 154
Trigonella foenum-graecum ... 95, 626
Tringa glareola ... 328, 464, 661
—— hypoleucos ... 660
—— ochropus ... 661
Trionymus sacchari ... 586
Trionyx ... 253
Tripogon bromoides ... 687
—— jacquemontii ... 687
—— pungens ... 687
Trirhogma caerulea ... 30
Triticum dicoccum ... 689
—— vulgare ... 599, 689
Triumfetta pilosa ... 94
—— rhomboidea ... 285, 287, 298, 299
Trochus ... 698
Troides helena cerberus ... 777
Troiometra ... 704
Troa aristolochiae goniopettis ... 777
—— coon doubledayi ... 777
—— varuna astorion ... 777
Trypoxylon ... 27
—— bicolor ... 27
—— intrudens ... 27
Turbo bruneus ... 698
Turdinirmus ... 578
Turdoides nipalensis ... 766, 767
—— somervillei ... 630, 890, 901
—— striatus ... 460
Turdus ... 578, 579
—— atrogularis ... 634
Turitella cerea ... 699
Turnix sylvatica ... 659
Tylenchus ... 90
—— marinus ... 89
Tylophora mollissima ... 841
—— tenuis ... 841
Tylosurus giganteus ... 324
—— strongylurus ... 324
Tyto alba ... 190
Uca ... 696
—— (Gelasimus) ... 696
—— annulipes ... 239, 508
—— dussumieri ... 510
—— marionis ... 509

PAGE
Uca marionis nitidus ... 239
—— —— *v.* nitidus ... 510
Udaspes folus ... 214, 783
Uliocnemis cassidara ... 153
Ulmus ... 226
Umbonium ... 698
—— vestiarum ... 698
Upupa epops ... 652
—— ceylonensis ... 329
Urentius echinus ... 238
—— sentis ... 607
Urochloa panicoides ... 297, 681
—— reptans ... 675, 681
—— setigera ... 681
Urocissa melanocephala ... 629
Uroconger lepturus ... 732, 733, 734
Uroloncha malabarica ... 643
—— punctulata ... 643
Uronema confervicolum ... 909
Uropeltis macrolepis mahableshwarensis 237
Urtica dioica ... 383
—— parviflora ... 383
Utethesia pulchella ... 591
Valeriana wallichii ... 880
Vallaris heynei ... 378
Varuna ... 518
—— litterata ... 405, 518, 530, 538, 543
Varanus bengalensis ... 327
Vaucheria geminata ... 916
Verbesina alba ... 175, 176
—— prostrata ... 475, 476
—— pseudo-acmella ... 175, 176
Vernonia cinerea ... 146, 284, 291, 298
—— conyzoides ... 291
Vermetus ... 699
Vespa cincta ... 33
Vetiveria lawsoni ... 677
—— zizanioides ... 677
Viburnum ... 366
—— coriaceum *v.* capitellata ... 843
—— cotinifolium ... 375
Vicia hirsuta ... 95
Vinca rosea ... 164, 292
Vigna catjang ... 960
Viola biflora ... 369
—— cinerea ... 103
—— distans ... 369
—— serpens ... 369
Vipera russellii ... 947
Virachola isocrates ... 620, 621
Vitex negundo ... 99, 149, 380, 960
Vitis pedata ... 144
—— quadrangularis ... 143
—— trifolia ... 144
—— vinifera ... 619
Viviparus bengalensis ... 254
Volvox aureus ... 908
Wallago ... 253
Waltheria indica ... 103
Withania somnifera ... 284, 292, 299
Woodfordia ... 643
—— floribunda ... 374
—— [frutisosa=] fruticosa ... 374
Wollea bharadwajae ... 919
Wrightia tomentosa ... 97, 285, 292, 299

PAGE

Xanchus 254
Xancus pyrum 700
Xanthium 710
———— strumarium ... 146, 291, 299
Xantho 427
——— (Leptodius) crassimanus ... 429
——— (————) exaratus ... 428
——— exaratus 428
——— hydrophilus 428
——— (Lophoxanthus) scaberrimus baccalipes 427, 430, 527, 535
Xylia xylocarpa 963
Xylocopa aestuans 36
———— amethystina 36
———— dissimilis 35, 36
———— latipes 35, 36
———— rufescens 36
Ypthima baldus baldus 779
———— hubneri hubneri 779
Yucca 101
Zanthoxylum alatum 371
Zea mays 297, 597, 675
Zela zeus 214
Zenkeria elegans 684
Zetides agamemnon agamemnon ... 777
——— doson axion 777

PAGE

Zetides eurypylus cheronus 777
——— sarpedon sarpedon 777
Zinckenia fascialis 305
———— perspectalis 304
Zizeeria otis otis 781
——— trochilus putli 781
Zizyphus ... 294, 381, 628, 631, 635, 640, 643, 645, 648, 713, 814
——— jujuba 143, 153, 155, 160, 288, 620, 626
——— mauritiana 711, 879
——— nummularia 288, 299
——— (numularia=) nummularia
——— oenoplia 160
——— rugosa 93, 105, 283, 284, 285, 962
——— (xylopora=) xylopyrus
——— (xyloporus=) xylopyrus
——— (xylopyra=) xylopyrus
——— xylopyrus ... 105, 286, 288, 298
Zoanthus 694
Zographetus satwa 214
Zootecus insularis 254
Zopoteredo 345, 671
Zornia diphylla 286, 289, 300
Zosterops palpebrosa 648
Zygnema sphaerica 913
——— ——— *f.* microspora ... 910

JOURNAL OF THE
BOMBAY NATURAL HISTORY SOCIETY

Vol. 54, No. 1

Editors
SÁLIM ALI & H. SANTAPAU, S.J.

SMITHSONIAN
MAR 15 1957
LIBRARY

DECEMBER 1956

Rs. 15

JOURNAL OF THE
ZOOLOGICAL SOCIETY OF INDIA

Published bi-annually, containing original papers and reviews in all branches of Pure and Applied Zoology

Annual subscription per volume of two issues:
Foreign: Rs. 22; Inland: Rs. 20.

A few back numbers are also available, subject to prior sale.

A few pages are reserved for advertisements at rates available from the Honorary Treasurer.

Reprints of a few papers of the Indian Helminthologist, the (late) Dr. G. D. Bhalerao, *Indian Journal of Helminthology* and Prof. Thapar Sixtieth Birthday Commemoration Volume, 1953, could also now be had from the Office of the Honorary Treasurer, Dr. B. S. Chauhan, 34, Chittaranjan Avenue, Calcutta-12, India.

All orders, remittances and communications regarding above should be addressed to the Honorary Treasurer.

RECENT PUBLICATIONS OF THE BOMBAY NATURAL HISTORY SOCIETY

Some Beautiful Indian Trees by Rev. E. Blatter, S.J., and W. S. Millard. Second edition. Revised and brought up-to-date. With 31 coloured and 37 monochrome plates, and numerous text-figures. Price Rs. 20.
(to members Rs. 16).

Some Beautiful Indian Climbers and Shrubs by N. L. Bor and M. B. Raizada. With 31 coloured and 99 half-tone plates, and numerous text-figures. Price Rs. 22.
(to members Rs. 17-8-0).

The Book of Indian Birds by Sálim Ali. 5th (New) Edition. With 56 coloured plates depicting 224 species, and 22 in monochrome from photographs. Price Rs. 20.
(to members Rs. 16).

CONTENTS OF VOLUME 54, NO. 1

PAGE

The Management of India's Wild Life Sanctuaries and National Parks, Part III. By E. P. Gee, M.A., C.M.Z.S. (*With one coloured and five black and white plates*) 1

Notes on Some Wasps and Bees (Hymenoptera) of Poona and the Western Ghats. By F. L. Wain, S.S.J.E. (*With a plate and* 21 *figures*) 22

Ducks Unlimited: And Wild Life Preservation in Ceylon. By Philip K. Crowe. (*With a plate*) 37

Chapters on the History of Botany in India. II. The Advances, and in particular the Plant Collecting, of the thirties and forties of the 19th century. By I. H. Burkill 42

Marine Nematodes from the Bay of Bengal. I. Phasmidea. By Richard W. Timm. (*With a plate*) 87

Vegetation of Pilani and its Neighbourhood. By N. C. Nair and G. S. Nathawat 91

Differential Response to Form and Pattern in two Species of Indian Honeybees. By K. K. Dixit, M.Sc. (*With two text figures*)... 107

Bionomics of the Pumpkin Caterpillar—*Margaronia indica* Saund. (Pyralidae: Lepidoptera). By R. C. Patel, M.Sc. and H. L. Kulkarny, M.Sc. (*With a plate and a graph*) 118

The Biology of Scorpions. By Max Vachon. (*With a plate and* 17 *figures*) 128

Some Useful Weeds in and around Cuttack. By H. Pattnaik ... 140

Notes on the Heterocera of Calcutta, Part III. By D. G. Sevastopulo, F.R.E.S. 153

Some Beneficial Coccinellids of Mysore. By M. Puttarudriah and G. P. Channa Basavanna. 156

Further Observations on the Biology of the Common 'Tree Hopper' *Otinotus oneratus* Walk. (Homoptera, Membracidae) in Orissa. By Upendra Chandra Panda and Basanta Kumar Behura. ... 160

*R*eviews :—

1. Powai the Angling Paradise (F.R.G.) 164
2. The Tigers of Trengganu (B. Basu) 164
3. Pelican in the Wilderness (R. R.) 166
4. The Flamingos: Their Life History and Survival (S.A.) ... 167
5. Embryology of *Heterometrus scaber*. (M. L. Roonwal) ... 169
6. The early Embryology of *Pyrilla perpusilla* Walker (Homoptera) (P.J.D.) 170

PAGE

Miscellaneous Notes :—

1. Macaque Monkey eating Mushrooms. By M. L. Roonwal (p. 171). 2. Lion *v.* Tiger. By E. P. Gee (p. 171). 3. Transferring of the Indian Lion to an additional Locality. By K. S. Lavkumar (p. 173). 4. Wild Elephants in the Union of Burma. By Tun Yin (p. 175). 5. A large pair of Elephant's Tusks from Burma (*With a photo*). By Tun Yin (p. 178). 6. Albino Elephants. By Tun Yin (p. 179). 7. Predator and Prey at Salt-licks. By E. P. Gee (p. 181). 8. Incubation Period and 'Mortality Rate' (?) in a Brood of the Magpie-Robin [*Copsychus saularis* (Linn.)]. By N. G. Pillai (p. 182). 9. Some Notes on the Plumages of *Centropus sinensis* (Stephens). By Humayun Abdulali (p. 183). 10. The Occurrence of the Pinkbreasted Parakeet (*Psittacula alexandri*) in Dehra Dun. By K. S. Lavkumar (p. 185). 11. Experiences with Little Ringed-Plover (*With a plate*). By Loke Wan-Tho (p. 185). 12. The Dimorphic Egrets. By J. Berlioz (p. 188). 13. Bird Notes from Kutch. By K. S. Lavkumar (p. 190). 14. Fighting among Birds. By R. S. P. Bates (p. 191). 15. Bird Migration in India. By Editors (p. 193). 16. The Changing Scene: Paucity of Bird Life in Jabalpur (M.P.). By P. V. Beatty (p. 194). 17. Solar Eclipse and Animal Behaviour. By G. H. Marsden (p. 194). 18. Jumping Snakes. By H. A. N. Medd (p. 195). 19. A Python's Meal (*With a photo*). By Tun Yin (p. 196). 20. Dhaman or Rat Snake (*Ptyas mucosus*) drinking Milk. By J. E. C. Turner (p. 196). 21. Strange Accident to a Frog (*Rana breviceps* Schneid.). By Humayun Abdulali (p. 197). 22. The Spawning of Carps. By J. D. Lovatt (p. 197) 23. On the Occurrence of Mummified Eels in the internal organs of *Polydactylus indicus* (Shaw) and *Pomadasys* sp. By K. H. Mohamed. (p. 199); 24. Occurrence of the Echiuroid Worm *Ikedella misakiensis* (Ikeda) in Indian Waters (Gulf of Kutch) (*With a text figure*). By P. W. Gideon, P. K. B. Menon, S. R. V. Rao and K. V. Jose. (p. 201). 25. The unusual resistance to starvation of *Saccharicoccus sacchari* (Ckll.). By D. V. Murthy (p. 202). 26. Some interesting Observations on the Royal Chamber in the Mound of the Termite *Odontotermes redemanni* (Wasmann). By B. Banerjee (p. 203). 27. Some common Termites of Calcutta. By Barundeb Banerjee (p. 204). 28. Notes on the Common Black Garden Beetle *Basilianus neelgherriensis*. By (Miss) M. E. Wolfe Murray (p. 206). 29. *Tarache nitidula* F., a Semilooper Pest on Cotton in South India (*With a plate*). By S. Venugopal (p. 207). 30. Partial Emergence of the Imagines of Dragonflies (Odonata) due to the absence of a holding place (*With two figures*). By D. R. Krishnan (p. 210). 31. Hesperiidae of the Khasi and Jaintia Hills. By Sir Keith Cantlie (p. 212). 32. Further Notes and additions to the List of Butterflies from Bombay and Salsette. By A. E. G. Best (p. 215). 33. On the phenomenon of Drumming in Egg-laying Female Butterflies. By Vidyadhar G. Vaidya (p. 216). 34. The Poisonous Qualities of *Calotropis gigantea* R. Br. By H. Santapau (p. 218). 35. *Parthenium hysterophorus* Linn., a new record for India (*With a plate*). By R. Seshagiri Rao (p. 218). 36. Notes on *Aerides maculosum* Lindl. (*With a text figure*). By H. Santapau and Z. Kapadia (p. 220). 37. Some New Plants for the Dangs Forest, Bombay State (*With two plates*). By H. Santapau and D. P. Panthaki (p. 221). 38. China's Book-like Rock Formation with 25-million year old Plant Fossils. By Prof. Hsen Hsu Hu (p. 225). 36. Wild Life Preservation in India. By Tolaram K. Mirchandani (p. 226).

Gleanings 228

Notes and News 234

Annual Report of the Bombay Natural History Society for the Year Ending 31st December 1955 235

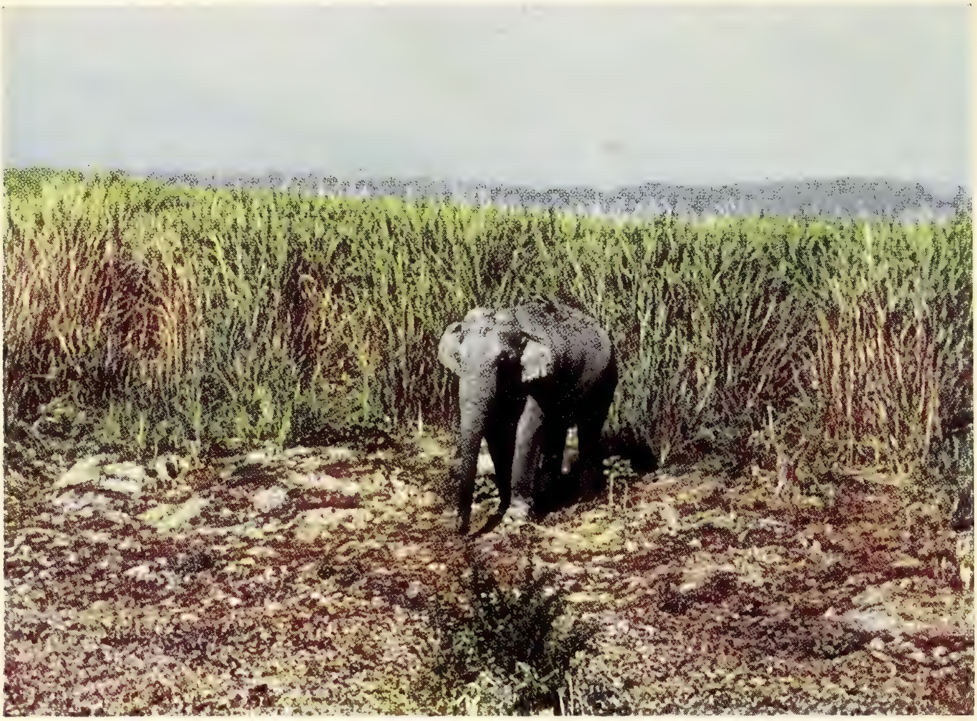
The Honorary Secretary's Report for the Year 1955 236

Appendix to the Honorary Secretary's Report Covering the Period January to August 1956 243

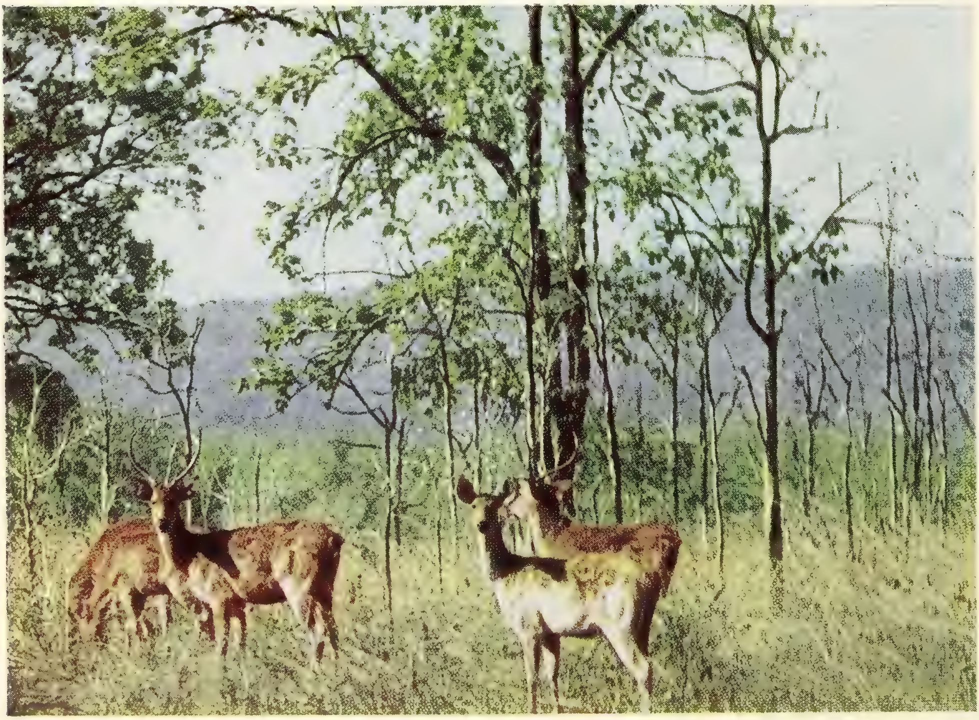
Minutes of the Annual General Meeting 245

Corrections 245

Statement of Accounts of the Bombay Natural History Society. 246



Wild Elephant (*makhna*), Kaziranga, Assam



Barasingha or Indian Swamp Deer in Kanha, Madhya Pradesh

(*Photos: E. P. Gee*)

506.54
B72
v.54
no.1-2
1956-57

JOURNAL
OF THE
BOMBAY NATURAL HISTORY SOCIETY

1956 Vol. 54 No. 1

THE MANAGEMENT OF INDIA'S WILD LIFE SANCTUARIES AND NATIONAL PARKS

BY

E. P. GEE, M.A., C.M.Z.S.

PART III

(*With one coloured and 5 black and white plates*)

CONTENTS

PAGE
INTRODUCTION 1
RECENT WORK OF THE INDIAN BOARD FOR WILD LIFE 2
PROPER LAND USE ESSENTIAL FOR WILD LIFE PRESERVATION 3
SOME POTENTIAL NATIONAL PARKS
1. Assam 5
2. Madras 6
3. Mysore 7
4. Saurashtra 8
SOME ADDITIONAL NOTES ON THE LIONS OF THE GIR FOREST
1. Indian Lion and African Lion 10
2. Different Varieties of Indian Lion 11
3. Introduction of African Lions into India 12
4. Natural Food Supply for the Lion 14
5. Compensation for Livestock killed by Lions 14
6. Number of Lions to be captured for Introduction into a New Locality ... 15
SPORT AND WILD LIFE PRESERVATION 16
'HIDES' FOR WILD LIFE PHOTOGRAPHERS 17
CONCLUSION 20
REFERENCES 21

INTRODUCTION

This paper forms the third of the series, Part I having appeared in the Society's *Journal*, Vol. 51, No. 1 (December 1952), and Part II in Vol. 52, No. 4 (April 1955). With the slow but gradual evolution of properly organised wild life conservation in India, with successive meetings of the Indian Board for Wild Life and its Executive Committee, and with more travels on my part around India's wild

MAR 1 - 195

life centres, it is inevitable that there should be a succession of these papers at two- or three-year intervals.

Since writing the last paper, a few places in Assam, Madras, and Mysore have been re-visited; but in particular the famous Gir Forest of Saurashtra was visited for the first time in January 1956, and the present paper naturally deals mainly with this most interesting place and its peculiar problems.

RECENT WORK OF THE INDIAN BOARD FOR WILD LIFE

Since Part II of this series was written, the activities of the Indian Board for Wild Life in connection with national parks and sanctuaries may be summarised as follows:

The Executive Committee and the Board itself met in Calcutta in January/February 1955 and discussed the need for clarifying the general principles that should govern the creation of national parks, wild life sanctuaries, and protected areas. The Board called attention to the following points:

(*a*) National Parks.

(i) National Parks are areas set apart by an Act of the competent Legislature for permanent preservation. Such areas may have for their objective the preservation of one or more of the following features: geological, pre-historical, historical, archaeological, scenic, faunal, and floral.

(ii) It is not an essential condition of National Parks that there should be no human intervention. Where it is desired to exclude human intervention altogether, it may be possible to set apart a suitable part within the National Park, a *sanctum sanctorum* which may receive absolute protection.

(iii) Such parks are not to be created lightly.

(iv) In framing proposals for the constitution of National Parks, the Board considers it desirable that State Governments should consult it and avail themselves of the technical knowledge and experience at its disposal.

(v) The Board recommends further that legislation to be enacted in various States for the creation and management of National Parks should follow a common pattern. In order to facilitate this, the Board will prepare and circulate a model draft bill.

(*b*) Wild Life Sanctuaries.

Wild Life Sanctuaries are areas ordinarily set apart by an Order of the State Government for the purpose of preserving wild life. The management of such sanctuaries is adequately dealt with under Resolution 6 'Protection of Nature and Wild Life' of the Mysore Session of the Board held in 1952. The Board recommends that sanctuaries conforming to the standard laid down under Resolution 6 (b) of the Mysore Conference may be constituted as such.

(*c*) Protected Areas.

In many States there may be areas where it may be considered expedient:

(i) to afford special protection to wild life, in order to enable species of wild life which are on the verge of extinction to re-establish themselves;

(ii) to afford protection to wild life attracted to water impounded in River Valley Projects and to other irrigation works;

(iii) to afford protection to wild life in and around large towns and sacred places.

Such areas may be constituted by an order of the Government, which may also lay down the degree of protection.

The Executive Committee of the Board met at Ootacamund in May 1955, and among other resolutions resolved to advise the State Governments that, pending the constitution of any sanctuaries into national parks, any attempt that might be made to change their existing character or whittle away their resources in any way should be guarded against. It also examined the Draft National Parks Bill clause by clause, and made a number of suggestions to be incorporated.

The Executive Committee again met at Sasan Gir in January 1956 and considered a great number of items dealing with wild life conservation in general. As regards wild life sanctuaries and national parks in particular, it was decided to collect information from all sources regarding the methods of preventing diseases contracted by wild life from domestic animals grazing in or near sanctuaries. The Draft Model Bill for National Parks, as finalised by the Law Ministry, was again considered before being sent to the State Governments.

In 1955 national parks were created in the following States: Kanha in Madhya Pradesh, and Shivpuri in Madhya Bharat.

Proper Land Use Essential for Wild Life Preservation

In most parts of the world nowadays the rapidly increasing human population, with consequent increasing demand for land for settlement, cultivation, and grazing, presents grave problems. When such a demand for land occurs near reserved forests or wild life sanctuaries, forest officers and wild life conservationists often find it difficult to convince land-hungry people that it is in the public interest to continue maintaining these forests and sanctuaries.

Moreover, there is a commonly held idea that wild life is something intangible and abstract, something to be appreciated by the select few who are able to comprehend the aesthetic, recreational, and biological value of flora and fauna. Even some educated persons in high positions in India have been known to exclaim 'We cannot afford to keep Kaziranga/Kanha/Gir Forest. Human beings are more important than wild animals. These places must be given up to settlement and cultivation.'

In such matters one must be realistic: the land-hungry people and their political leaders can produce facts and figures to support their case, and so we must be in a position to prove that a good wild life sanctuary has a greater value to the country as such, rather than just as an area of land to be opened up for settlement or grazing. Otherwise, if we cannot show good reason why Kaziranga/Kanha/Gir Forest should continue to be maintained as wild life sanctuaries or national parks, then we will sooner or later lose them.

It is really all a matter of proper and effective land use. Land must, in all places, be put to the best possible use after taking into consideration each particular case; and it must be carefully considered whether a sanctuary or national park is more valuable to the country as a whole if it is maintained as such, or if it is opened up for settlement, cultivation, and grazing.

As wild life has dwindled and is still dwindling very rapidly, and as wild life and beautiful unspoilt scenery are a priceless irreplaceable heritage and a most valuable national asset, it is obvious that sanctuaries must be safeguarded, even if it may bring some temporary unpopularity on those who have to enforce such measures.

To get down to rock-bottom facts and figures, I will state the general position at one of India's foremost sanctuaries, Kaziranga in Assam. In recent years several square miles of valuable sanctuary land within the southern boundary, favourite haunt of rhino, wild buffalo, and deer, and accessible to visitors even in the rainy reason, have been opened up to villagers for grazing their tame buffaloes and cows. This pressure on the sanctuary is increasing, as the following figures of domestic buffaloes allowed to graze inside the sanctuary show:

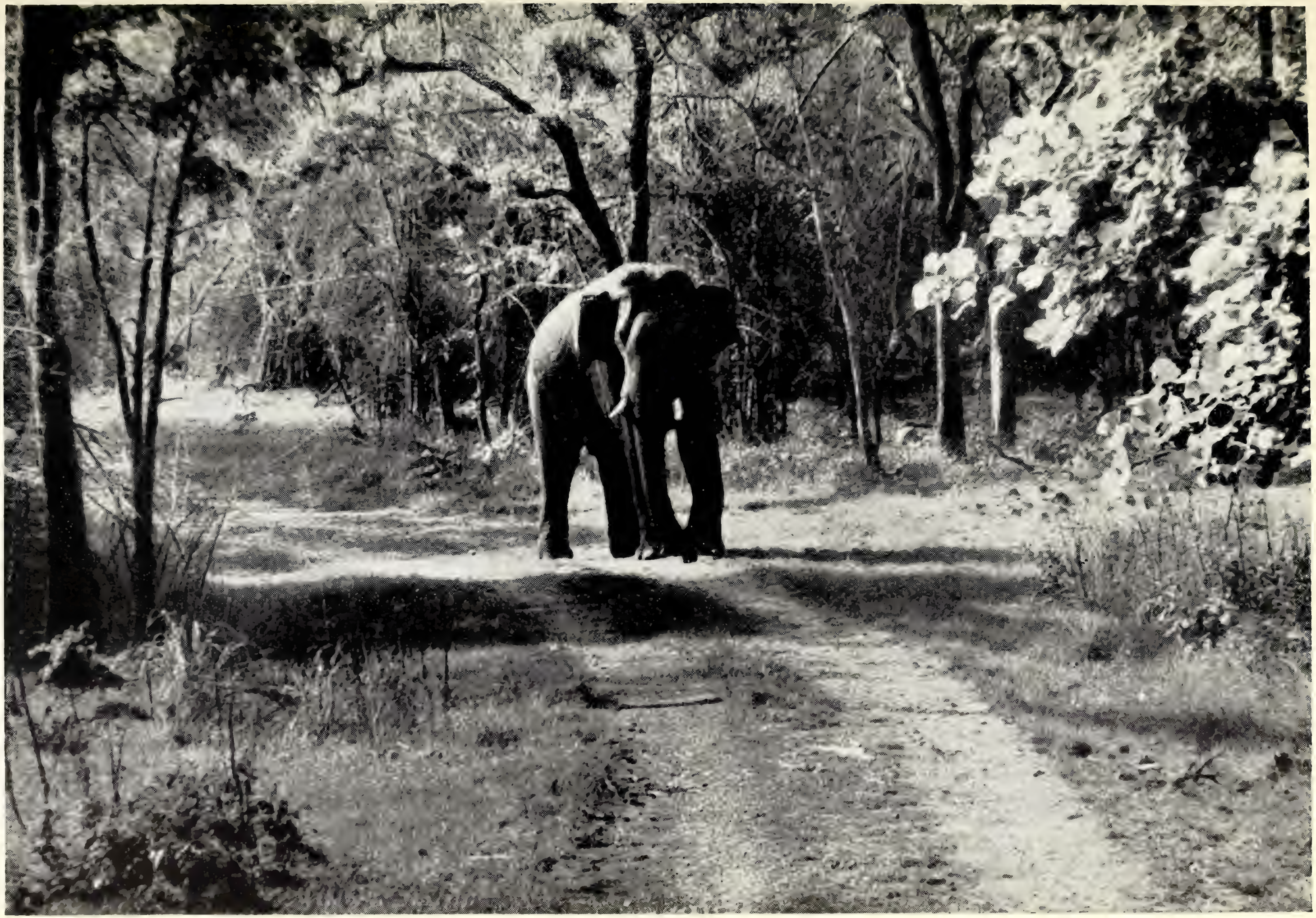
Year	*Number of domestic animals allowed to graze inside the sanctuary*
1950	100
1954	500
1956	1000

If this rate of encroachment is allowed to continue and if similar encroachments are allowed in other parts of the sanctuary, with accompanying cattle-borne diseases spread among the wild animals, there will be very little left of Kaziranga and its unique fauna in fifty years' time.

Now the following figures show the tourist or economic value of Kaziranga, with consequent revenue for Assam in particular and for India as a whole:

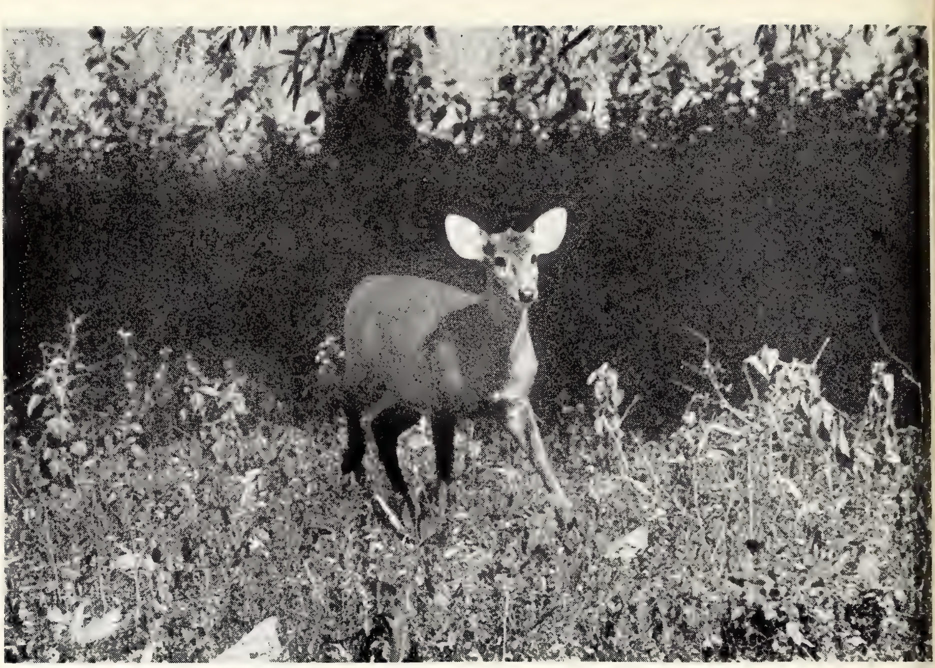
Year	*Visitors from abroad*	*Visitors from India*	*Total*
1950–51	25	21	46
1951–52	78	42	120
1952–53	167	106	273
1953–54	172	134	306
1954--55	188	306	494
1955–56	287	616	903

As revenue from the tourist trade is an indirect one, not confined to one place but spread over the whole country visited, it follows that for every Re. 1 spent by foreign visitors at Kaziranga about Rs. 30 or 40 are spent in the rest of India. Therefore for every Rs. 6,000 (the amount paid by foreign tourists at Kaziranga in 1954-55) spent here, about Rs. 2,10,000 are spent in the rest of India. And if the increase of popularity of Kaziranga continues at the

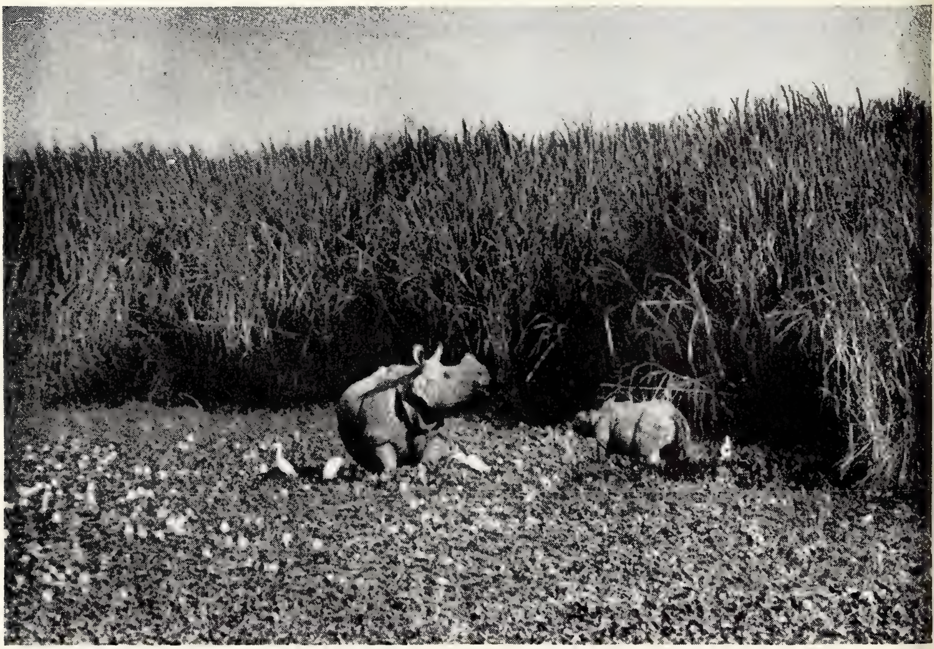


Wild Tusker Elephant in Bandipur, Mysore.

(*Photo : E. P. Gee*)



Hog Deer in Kaziranga, Assam.



Mother and baby Great Indian One-horned Rhinoceros in Kaziranga, Assam.

(*Photos : E. P. Gee*)

above rate, the revenue to Assam and India will be very great indeed in fifty years' time.

It is clear, therefore that the economic value of Kaziranga as a wild life sanctuary is so important to Assam and to India that this piece of land (166 square miles) should be preserved inviolate with sacrosanct boundaries as a national park. All possible steps should be taken so that the local surplus village population with their increasing cattle should be given land and grazing facilities elsewhere, or else the numbers of their cattle reduced.

So far, then, from not being able to afford to keep Kaziranga/Kanha/Gir Forest, we cannot afford to lose such places.

This very same problem occurs all over India, and the case of Kaziranga is duplicated in most other States. In fact it is found all over the world; and as George Petrides (1955) has pointed out in his admirable 'Report on Kenya's Wild Life Resources and the National Parks', Kenya's wild life and the tourist trade brought by it are of the utmost value to the country as a source of considerable national income. He has established that improper land use is chiefly responsible for the diminution of Kenya's wild life, and that complete wild life habitats should be carefully preserved.

It is perhaps not fully realised in India that the potential value of her wild life as a source of revenue from tourists is very great indeed. Wild life is an important industry, even in the U.S.A. In Kenya wild life ranks as the third most important industry after coffee and sisal. Tourists who go to see, and occasionally shoot, wild life in Kenya spend about four crores of rupees annually there. Each year there are about 1,00,000 visitors to the Nairobi National Park alone to see its wild life.

Wild life is an industry as tangible as tea, oil, jute and coal, for which land is required to be set aside in select areas for the benefit of the whole country for all time.

Some Potential National Parks

The following places, all potential national parks of India, were visited by the writer since the previous paper was written, and observations were made as under:

1. Assam. In December 1954 the new Tourist Lodge at Kaziranga was opened to visitors. Specially constructed for visitors to the sanctuary, this five-roomed ten-bedded rest house has modern sanitation and electric light. It is fully equipped in every respect for visitors, who need now bring nothing with them in the way of bedding, food, servants etc. A new tree-top house has recently been constructed north of Hulalpat Camp, but I have not yet had the opportunity of visiting this place. A set of eight picture postcards depicting wild life in Assam has been printed, 1000 of each, for sale to visitors. This is an encouraging step in the right direction.

A rest house has also been built at the foot of the hills near the Manas River in the North Kamrup (Manas) Sanctuary. When the new access road, aligned to avoid erosion by the river, becomes consolidated and when the rest house is fully equipped, this sanctuary should be a most attractive place for visitors. No more has been heard of the proposal for requesting the Bhutan Government to create a sanctuary on their side of the border, adjacent to the Assam sanctuary. It is to be hoped that a move in this direction can be made before it is too late.

Unfortunately no progress has been made with the draft Assam National Parks Bill, by which it was hoped that by now these two fine wild life sanctuaries of Assam would have gained the status of national parks.

A small one-and-a-half-square-mile wild life sanctuary was created at Garampani in 1952; and since poaching has been reduced at these seven salt-licks and hot-springs the number of wild animals and birds to be seen there has increased considerably. Considering that this area is famous for butterflies and plant life as well as for wild life, Garampani Wild Life Sanctuary deserves full attention for strict protection and development.

2. Madras. I re-visited Mudumalai Sanctuary on the afternoon of May 10th and morning of 11th 1955, staying the night at the Kargudi Rest House. I must congratulate the Madras Government on a considerable all-round improvement in the administration of this place since my first visit made in 1950. The Rest House had been improved and was cleanly kept. A separate 'game staff' had been provided purely for wild life preservation in the sanctuary, and consists of one game warden, one assistant game warden, two forest guards and two watchers. This staff works within the Forest Department, with no forestry duties to perform, and thus is able to concentrate on the elimination of poaching and the observation and protection of wild life. This is just the kind of administration required for sanctuaries in India under the present policy of not having a separate wild life department.

There was no fee for cameras, and this is a wise policy, especially as the forest and undergrowth are very thick and photography correspondingly difficult. I obtained no photographs during my two visits, although my three cameras were held ready all the time.

The extensions to the sanctuary, I understand, are still in the proposal stage, and shooting in these blocks has not yet been stopped. As I was unable to visit these parts I am unable to comment on the desirability or otherwise of these extensions; but in general it is considered that a larger wild life sanctuary is preferable to a smaller one, provided it can be effectively administered.

I make the following suggestions, not in a critical sense but as ideas for the further improvement of the sanctuary:

1. As the forest is very thick with an annual average rainfall of 65″ compared with 38″ at Bandipur, and as the viewing of wild life is difficult with photography still more difficult, I think the possibility might be considered of creating a few grassy areas or *maidans* of, say, 200 or 300 yards in width, in suitable areas accessible to visitors, where wild life could be viewed in the open, as at Kanha in Madhya Pradesh.

2. Salt-licks and water-holes could be made at these open places, so that wild life can be easily located, seen, and photographed.

3. More motorable link roads would be a great advantage, with Bandipur as the ideal.

4. Exploitation of timber and plantations of young trees might be eliminated in the vicinity of the Rest House and the parts chiefly visited by visitors, so that the conditions of an 'inner sanctuary' might be fulfilled.

5. At least 75% of the wild dogs should be destroyed. I saw wild dogs on three occasions in only two visits, and on one of these occasions a chital was being chased.

6. The charge for a night at the bungalow could be increased from Re. 0-8-0 to about Rs. 2 or Rs. 3, and more amenities provided such as a filter and drinking water.

7. The compound of the bungalow could be improved with flowering trees, shrubs and plants (preferably local indigenous flora, rather than the ordinary flowers found in gardens in towns).

8. A pamphlet describing the sanctuary and its wild life, with map and illustrations, would be very advantageous.

9. I noticed new signboards, with 'Mudumalai Game Sanctuary' and the title 'Game Warden', were being used. The word 'game' could in all cases well be replaced by the words 'wild life', in accordance with the general policy adopted in India.

3. Mysore. I re-visited Bandipur Sanctuary on the afternoon of 12th and morning of 13th May 1955. Coming here immediately after Mudumalai, I was struck by the difference in vegetation etc. With an annual average rainfall of about 38″, instead of 65″ at Mudumalai, the forest was sparse, stunted and without much undergrowth at this time of the year, making conditions ideal for viewing and photographing wild life, in most photogenic surroundings.

My visit on 12th was unfortunately marred by the continuous breaking down of the Forest Department lorry which was taking me round. A herd of about 30 'bison' was observed, but they may have been frightened by the misfiring of the lorry engine and were very wary. No photographs were obtained.

The morning visit on elephant-back was better, and in addition to chital and peafowl I saw and photographed a fine tusker elephant.

Some suggestions for the even further improvement of the sanctuary were made by me in December 1952, and to these I would add the following:

1. The right vehicle for visitors to see the sanctuary from, I think, is not a lorry but a Land-Rover with a station-wagon or truck-like body, with a trapdoor in the roof for photography. In East Africa I tried out every kind of vehicle, including a Bedford Hunting Truck and Land-Rovers with truck-like bodies and trapdoor ('sunshine') roofs. The latter were the best, and could seat 6 people comfortably, and are cheap on petrol. I used this kind of vehicle in tours in Kenya, Uganda, and Tanganyika, leaving the road and going right across country at times.

2. I saw a 'tiger block' with a sandy path being prepared all round it, presumably for tracking down a tiger, adjacent to the sanctuary boundary. I hope that tigers are not being shot in the adjacent forests.

3. The tiger, which is the most spectacular of beasts in India, and possibly the world, is the very animal most sought after by visitors to see and photograph. If any sanctuary in India can 'lay on' a tiger for visitors to see, this will be the sanctuary or national park *par excellence*. Possibly some artificial means would have to be employed, viz. keeping a tame or semi-tame tiger in an enclosed area, or feeding wild ones regularly (with 'doped' meat?), or even making a natural-looking enclosure with a moat all round as in the Mysore and Travancore Zoos, only larger in extent.

There might be an objection that such a tame or semi-tame tiger would appear unnatural, while the 'purists' might object simply on principle. But how otherwise can we show our tiger to visitors? The vast majority of the public, who have few chances of visiting sanctuaries, would welcome such a step. And after all, many of the lions of the national parks of Africa have for various reasons (among which man-given meat can sometimes be included) become semi-tame and display themselves openly to the many thousands of visitors who come from all parts of the world to see them, thus bringing in a substantial revenue to the country and giving a fillip to the cause of wild life preservation.

In this connection it is interesting to note that Champion (1939) expressed the conviction that the tigers of the Hailey National Park would in due course 'carry on their daily life regardless of the presence of human beings in the way that lions are now to be seen doing in the national parks of Africa'. As they have not done so, then other means should now be tried so that these fine creatures can be seen and enjoyed by visitors.

4. Saurashtra. A meeting of the Executive Committee of the Indian Board for Wild Life at Sasan Gir from January 18th to 20th 1956 gave me the long awaited opportunity of seeing the famous Gir Forest and its lions. Two extra days were very kindly allowed by the hospitable Government of Saurashtra, making a total of five days altogether. Under the personal and knowledgeable guidance of the Jam Sahib of Nawanagar we were shown lions; and all the available information was given to us. Thus by studying the material that has been written about the Gir and its lions, by listening to all that was told us by our hosts the Rajpramukh, the Minister, the Conservator, and others, and supplemented by personal observation, it was possible even in the short space of five days to come to a few general conclusions about what must be one of the most complex and interesting wild life centres of India.

It was particularly interesting for me to see the Indian lion in its habitat, after my visit to East Africa where the African lion is one of the main attractions.

I will confine myself to only a few broad generalisations about the Gir, and will avoid touching on such aspects as description, history, census, forest operations, etc., which have been so ably dealt with by others. In fact most of my observations will purposely be of such a general nature, as rather to be the basis of future and more detailed investigations than attempts at passing final verdicts, which can only be arrived at after very much more thorough and prolonged field work.

The first thing that struck me was that here was a first-class potential national park, which did not enjoy the status even of a wild life sanctuary! At the time of writing this paper the Gir is a region consisting partly of Reserved Forest and partly of village settlements, cultivation, and grazing areas, through the whole of which runs a railway and some roads. It was explained to me that as there were villages, cultivation, and grazing of domestic livestock in the lion areas, therefore they had not been created a national park.

If this is so, then this must surely be the result of a misunderstanding. For while it is true that the generally accepted definition of an ideal faunal national park is an area free from human settlements etc., it should not follow that because there happen to be some human settlements in an area therefore that area cannot become a national park! Many of the world's finest faunal national parks have villages and grazing of livestock inside them, such as the Nairobi National Park in Kenya, the Serengeti National Park in Tanganyika, the Queen Elizabeth National Park in Uganda, and the Kafue National Park in N. Rhodesia.

For more detailed examples, there are 198 Somalis living in the 40-square-mile Nairobi Park, with 200 head of cattle. In the 5,500-square-mile Serengeti Park there are approximately 2,000 Masai and others living in the park, with their 3,00,000 head of cattle, sheep, and goats. In the 756-square-mile Queen Elizabeth Park there are villages containing about 2,000 inhabitants, though their livestock is few in numbers due to tsetse fly.

It is obvious that where there is good grazing for wild herbivorous animals, there is also good grazing for domestic animals, with accompanying human settlements. This is the big problem in East and Central Africa: how to reconcile the two diverse objectives of wild life preservation and safeguarding the interests of the indigenous and sometimes nomadic human populations.

If such villagers can be moved by rehabilitation, or if their villages can be excised from the proposed national park, then so much the better. But if they must be included, and if for political and other reasons the grazing by their livestock cannot be prevented, then at least this can be restricted, controlled, and regulated after a careful study of the conditions and in conformity with a wise policy of effective land use.

In this respect we can learn an interesting lesson from East Africa. When, for example, the Serengeti National Park of Tanganyika was created, it was laid down that the rights of the indigenous local inhabitants would be safeguarded. But these 'rights' were never defined. Consequently these indigenous inhabitants can now at any time hold a meeting and demand something as a right, which it is very difficult for Government to oppose. Moreover, more people may come into a park from outside and cattle may increase enormously in numbers, making subsequent control extremely difficult. Further, the habits of the villagers may change: for example the Masai in East Africa never used to hunt wild animals, but since intermarrying with other tribes has taken place some of them have now taken to hunting, with consequent detriment to the wild life of the national parks.

When the Queen Elizabeth Park of Uganda was being created in 1952-54 there was some opposition, and the 2,000 villagers resident within the boundaries of the proposed park were allowed to remain. But regulations ensure that no cash crops are allowed to be grown by them, and only sufficient cultivation is allowed to be done for the production of their own food. No hunting is allowed. A fishing village area was excised entirely from the park.

From all the foregoing facts, then, it follows that the Gir Forest could be created a national park with some, if not all, of the *maldharis* and others remaining there with their livestock, provided that suitable legislation is enacted clearly defining their rights, demarcating the boundaries of their land for cultivation and grazing, regulating the numbers and types of their livestock, ensuring that precautions are taken against cattle-borne diseases, prohibiting further inroads of men and livestock from outside, and so on.

In fact the villages in the Gir, the *maldharis*, and their beasts can even be regarded as a picturesque attraction of a future national park, providing interesting subjects for sightseeing and photographing by visitors.

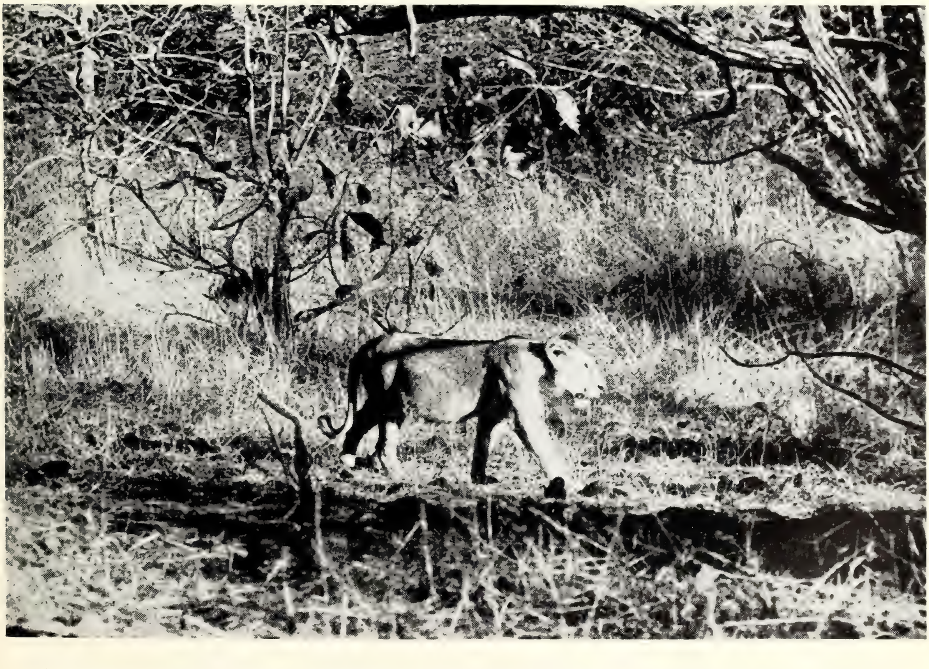
There is not a shadow of a doubt that the Gir Forest and its lions, as well as its other wild animal and bird life, would rank as one of the best national parks of India. Its close proximity to Bombay, the threshold of India's tourism, is an additional attraction. It is only one-and-a-half hour's flying from Bombay to Keshod and one-and-a-half hour's motoring time from Keshod to Sasan Gir, where a palatial Guest House with numerous well-equipped rooms awaits a regular stream of tourists and visitors. These potential tourists and visitors do not come only because there is no publicity, no provision for their reception, and no open-for-all arrangements to show them the lions.

A further attraction to the Gir as a national park should be the new one-and-a-half square mile lake due to be formed by the dam over the Hiran River. In fact a veritable 'Periyar' in the heart of the lion country is about to come into existence, with the two-fold advantage of perennial drinking water for wild life and scenic beauty for human visitors.

Some Additional Notes on the Lions of the Gir Forest

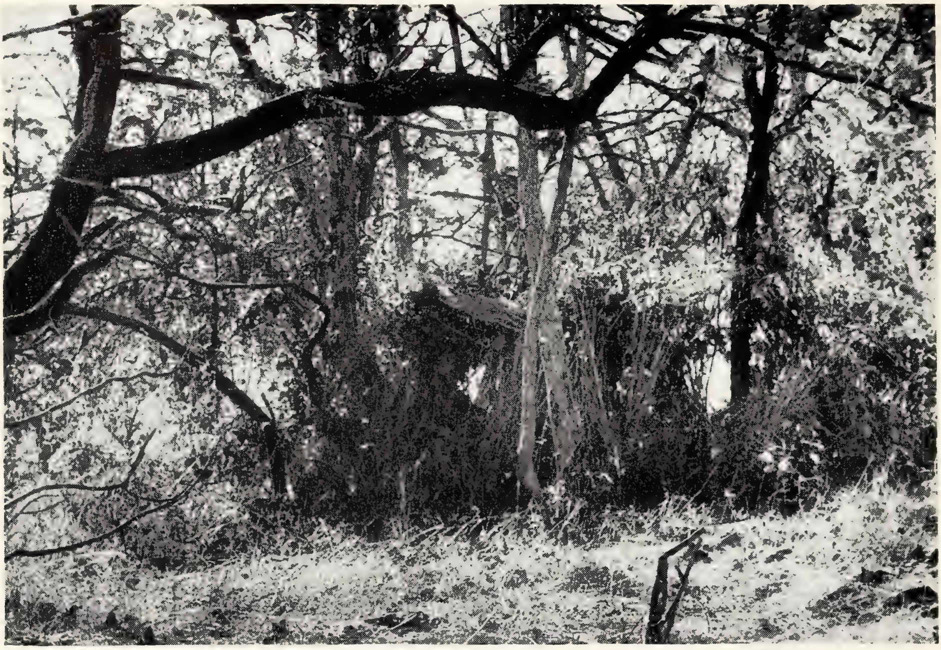
1. Indian Lion and African Lion. A careful comparison of lions as seen in my cine films of East Africa and of the Gir reveals that the Indian lion is perhaps a little stockier, a little shaggier, less whitish in the underparts, less dark in the head and neck, has a bigger tuft on its tail and has a mane not quite as big. The common notion that the Indian lion is a maneless or mangy beast is quite erroneous. I was very impressed with the lions which I saw in the Gir, which numbered seventeen in four days of looking for them. Four lions with reasonably good manes were seen, and the lionesses were fine animals.

Typical thorny scrub on the fringe of the Gir Forest. Two of a pride of five Lions can be seen on a 'kill', while a kite circles overhead in anticipation.

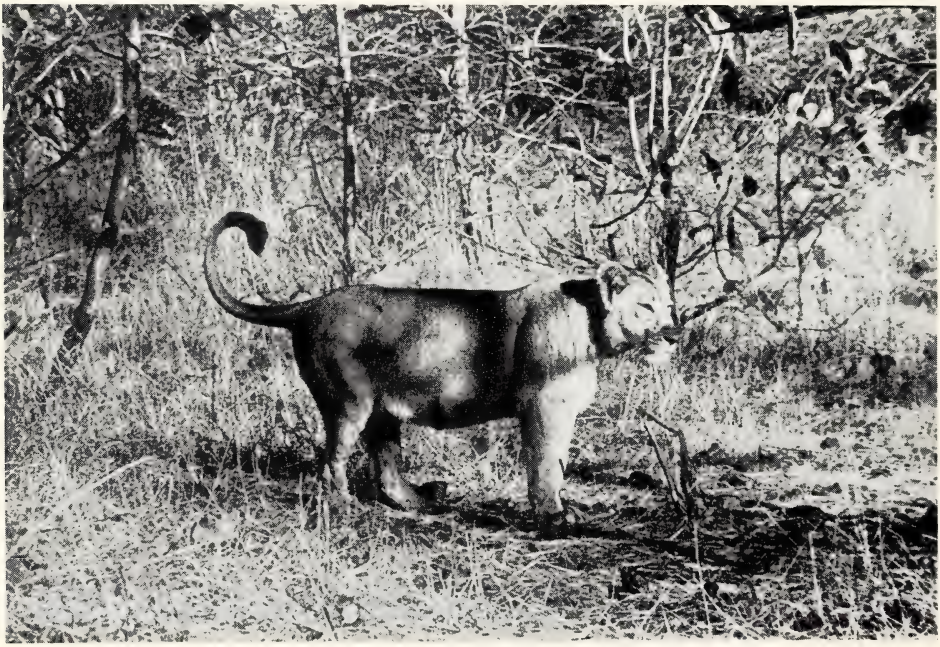


A young male Lion, with mane starting to grow, comes out to a 'kill'.

(*Photos : E. P. Gee*)



A hurriedly constructed 'hide' for photographing lions. (This is the lions' view of the 'hide'.)



A young adult male Lion photographed from the above 'hide'. Its mane has not yet developed.

(*Photos : E. P. Gee*)

Regarding size of manes of maned lions, it has often been pointed out that the presence of thick undergrowth, thorny scrub, etc. in India is a deterrent to the growing of big manes. It is claimed that the manes of Indian lions get too much 'combing' and are consequently smaller than those of their African cousins. R. I. Pocock, (1939), however, does not agree with this. He says: 'This notion that the combing action of thorns accounts for the scantiness of manes in many lions has often been thoughtlessly quoted with approval as supplying a satisfactory explanation of the fact. There is not a word of truth in it. The most that thorns could achieve would be keeping the mane tidy by the removal of dead, moulted hair, which might for a time adhere to the growing mane before being shed. They could no more affect its potential luxuriance than the daily use of a comb can reduce the quantity of living hair on a woman's head'.

I feel myself that further field investigations and zoological garden study are needed to decide this matter. A possible explanation of the slightly smaller manes found on Indian lions could be found in the fact that their Gir Forest habitat, which is only about 200 to 400 ft. above sea level, has a much hotter climate; whereas in Africa the lions range over comparatively cool uplands of 3,500 to 6,000 ft.

Another reason for the lack of lions with really good manes in the Gir may be found in the custom in the past for V.I.Ps. to come and shoot. Up till quite recently, a quota of about four lions were officially allowed to be shot annually, and as a maneless or poorly-maned lion is no trophy, only the lions with the largest manes got shot, inevitably resulting in a stock of lions with smaller manes. Fortunately this custom has now ended, and Indian lions are fully protected by the Government of Saurashtra. It is to be hoped that if any reduction in numbers is ever contemplated in the future, then only the aged and sickly lions and lionesses will be destroyed by persons specially deputed for the job by the authorities in charge of administering the area.

Wynter-Blyth (1956) considers that the number of lions has already increased sufficiently to necessitate a reduction in their numbers, in order to prevent overstocking within the limits of the Gir Forest and to counter inevitable complaints from the *maldharis*. With his great experience of the area he is most probably right in this. But his suggestion that five or six permits per annum to shoot lions might be given as an experimental measure is fraught with the very danger referred to above, unless such permits are given only for lions outside the Gir Forest and only for lions without good manes.

2. Different Varieties of Indian Lion. The Jam Sahib of Nawanagar, whose knowledge of the Gir lions is only equalled by his intense interest in them, has informed me that there are two distinct varieties of lions in the Gir. These are described as (i) the 'donkey' variety, more vertical-shaped, bigger, fiercer, and which go in prides of up to six in number, and (ii) the 'waler' variety, more horizontal-shaped, smaller, better natured, and which go in prides of up to fourteen in number.

The Conservator of Forests, Saurashtra, has also informed me that there are 'two distinct sizes of lions in Gir Forests'. But I cannot find this theory substantiated in any journals or books, and consider that this would be a most interesting subject for study in the field. Any evidence to prove or disprove this theory would have to be supported by measurements or photographs of living animals.

3. Introduction of African Lions into India. It is known that three pairs of African lions were imported from Africa into India (in about 1916) by the Maharaja of Gwalior,[1] but these were quickly shot out owing to their lack of fear of human beings after a short spell of captivity. As Gwalior, which is SSE. of Delhi, is a very considerable distance from the Gir Forest, it is presumed that there can have been no mixture of African blood as far as the Gir lions are concerned. I am personally against the introduction of African lions into any part of India, and would prefer the Indian lions to remain as 'pure' as possible.

I do not think that any African lions have ever been brought into the Gir, but am indebted to R. W. Burton and E. C. Apcar for drawing my attention to the following newspaper report which alleges that this was in fact done about the year 1890.

According to an article by Lovat Fraser published in a newspaper in India (about 1924?), some African lions were alleged to have been introduced into the Gir prior to the shoot arranged (about the year 1890?) for H.R.H. the Duke of Clarence, elder brother of (later) King George V.

This newspaper article reads: 'When the Duke of Clarence's visit was announced the Junagadh authorities, fearing that he might not get good sport, secretly obtained a number of African lions which were brought across the Indian Ocean in native sailing vessels and turned loose in the Gir. They multiplied amazingly, they were far more formidable than the Indian lions, and they had big manes'.

According to the article, it was not until about 1908 or 1909 that the news of the reported introduction of these lions from Africa leaked out. In 1906, the article continues: 'Lord Lamington, then Governor of Bombay, and several others went to the Gir to shoot . . . At the first day's shoot three lions and a lioness were killed. Lord Lamington, Colonel Kennedy and Sir James du Boulay each got a lion. Major Carnegy, the local Political Agent, was attacked by a wounded lioness and instantly killed, whereupon the camp was broken up . . . The lions all had large manes and were much larger than Indian lions. Sir James du Boulay's lion measured 11 ft., and Colonel Kennedy's was 10 ft. 10 in. I was present at the shoot and noted the measurements myself. The manes and measurements produced much mystification. It was not until two or three years later that the mystery was privately explained.' (Then follows the passage quoted in the previous paragraph.)

The belief that 'they multiplied amazingly' is easily explained: the Jam Sahib has informed me that in those days the Nawabs of Junagadh used purposely to let it be known officially that the number of lions in the Gir was very low, about 12 or 13 only. This was because every British Viceroy, Commander-in-Chief, Governor of Bombay, Indian Princes, and others down to persons of less importance were in the habit of longing to be invited to shoot a lion. Even Lord Curzon at the turn of the century was informed that there were only about 12 lions left, and therefore he refrained from shooting and encouraged the preservation of the lions instead. Actually there must have been about 100 lions in existence in those days, if not more. So naturally anyone actually going there and shooting lions would be surprised at the real number of these beasts in the Gir.

---

[1] See the note 'Experiments in implanting African lions into Madhya Bharat' by Col. Kesri Singh, *JBNHS*, **53**: 465—Eds.

The belief that the 'African' or 'mixed African-Indian' lions were 'far more formidable than the Indian lions' may to a certain extent be discounted by the following historical fact: M. A. Wynter-Blyth and R. S. Dharmakumarsinhji (1950) have pointed out that the years 1899 and 1900 were famine years in the Gir, and that in 1901-1904 'almost all the game in the forest had died off, and the lions . . . were living on the edge of the Gir and preying solely on cattle with occasional human victims.' And that subsequently (about 1904-1911) 'the habits of the lions underwent a profound change, for never again are they heard of as a menace to human life. This was in all probability the result of a return to normal conditions after the famine years.'

The record-breaking measurements given above are even more easily explained in L. L. Fenton's book 'The Rifle in India', where the author says: 'At the time of Lord Lamington's shoot in the Gir, when Captain Carnegy was so unfortunately killed by a wounded lion which three of the party were engaged in following up, it was stated that one or two lions which were then shot measured over 11 ft. in length, but it afterwards transpired that the measurements were taken after the animals had been skinned, and they are, therefore, obviously of no value.' As L. L. Fenton was present at the shoot in question as an organiser, his explanation of these outsize measurements can be taken as the correct one.

Another explanation, if such were needed, of such 'record' measurements is this: I am informed that there used to be a system of measuring lions for V.I.Ps. in the Gir which consisted of pulling out the front legs and measuring from the front claws up to the nose and round all the curves.

I have enquired from the appropriate authorities in Saurashtra as to the possibility of there being any truth in the newspaper report of African lions being brought by *dhows* to the Gir. Not only do there appear to be no records or even legends of it ever having happened, but also the report can be discounted for the following reasons:

(i) There was no real shortage of lions in the Gir at the time. (The official low 'estimate' of 12 or so has been previously explained.)

(ii) The voyage from East Africa to Junagadh by *dhow* takes at least two months, and as no *dhow* would attempt the voyage till the monsoon was over lions could not be brought in time for cold weather shoots.

(iii) A very large meat supply 'on the hoof' would have been necessary, making such a project almost impossible.

(iv) Even if such 'imported' African lions were let loose after being caged during a sea journey of at least two months in a *dhow,* they would have quickly fallen victims to the Gir lions.

A possible clue to the start of such a rumour may lie in the following extract from L. L. Fenton's book concerning the shoot for the Duke of Clarence: 'At daybreak I had a visit from the Dewan, who . . . came over to suggest that, rather than that the Prince should be allowed to leave the Gir without bagging a lion, two lions which had been sent out from Junagadh during the night, confined in cages or carts, should be set free in the jungles, and then be driven out to be shot . . . Of course, neither Colonel Kennedy nor I would entertain the Dewan's suggestion for a moment . . . So the matter was dropped, and the lions were sent back to their home in Junagadh. I have often wondered since how the latter would have acted had they been set free.'

4. Natural Food Supply for the Lion. It was reported to us that many of the wild deer and antelope, which in addition to domestic livestock form the food supply of the lions, had died of foot-and-mouth disease. It was, therefore, suggested that additional *nilgai* might be captured and imported from elsewhere. This would surely be a very costly venture.

Probably the following steps to increase the natural food supply for the lions would be adequate:

(i) Reduce the incidence of cattle-borne diseases by strictly controlled prophylactic measures, and by the prohibition of more domestic animals being brought in from outside.

(ii) Reduce or prevent any possible shooting of deer and antelope by sportsmen and poachers.

(iii) Put an end to the publicising of wild pig (a valuable lion food) as vermin to be destroyed on all possible occasions.

(iv) Reduce the number of panthers which account for a large number of deer, antelope and pig.

5. Compensation for Livestock killed by Lions. A problem in the Gir Forest and its surroundings is the payment of compensation liable to be claimed by *maldharis* and others for domestic animals killed by the protected lions. While it may be argued that people who choose to live and graze their cattle close to the habitat of carnivora in order to get good cheap grazing must face the risk of losing some of their stock without compensation, there are other aspects of the problem which must here be taken into account, e.g., the historical precedent set by the former Ruler, the Nawab of Junagadh.

My own humble suggestion on this point is that as such 'kills' by lions are exactly what are wanted by tourists and visitors to the Gir, a proportion of the revenue obtained from visitors could be allocated as part compensation to the *maldharis* who lose buffaloes and cattle. In other words, when a cow or buffalo is killed by a lion, the owner should immediately report the matter to the appropriate quarter. Visitors could then be rushed out to the spot (if it is the right time of the year) to observe and photograph the lions from a 'hide', on payment of duly prescribed fees. A substantial revenue would ensue, a portion of which could be earmarked as part compensation to the persons who have suffered loss of livestock.

6. Number of Lions to be Captured for Introduction into a New Locality. It is proposed to catch and move a few Indian lions from their present one and only refuge in the Gir Forest to an additional locality within their former range and with suitable conditions of environment. First of all a small area of Tikamgarh in Vindhya Pradesh was contemplated for this venture. More recently it has been provisionally agreed to catch and transfer a few lions on an experimental basis to the Chakia Forest south-east of Banaras in Uttar Pradesh, where conditions are reported to be favourable for the re-introduction of these animals. If the experiment takes place and succeeds, it may be repeated in one or two other parts of India where lions formerly existed, where local present-day conditions are suitable and where natural food supply is available.

In selecting an area for the re-introduction of lions firstly the supply of natural food (deer, antelope, pig etc.) must be adequate; secondly the area should be free of tigers which would obviously resent and oppose the invasion of their territory by other large carnivorous animals and thirdly the villagers and other members of the public in the vicinity should be prepared by suitable publicity beforehand so that they would welcome and assist the experiment.

A problem now confronting us is this: when the time comes to catch and transport a few lions to, say, Chakia Forest, how many should we transport? At first we thought of a pair of lions, or two pairs. Then it was pointed out by a correspondent that perhaps the ratio should be one lion to two lionesses, and that two lions and four lionesses would be the ideal number to transport.

Again more recently it has been maintained that as lions live in family groups, a complete family should be caught and sent to the new home. But what should be the future breeding prospects of such a family party, except that grown-up male cubs would have to pair with their mother and sisters, if and when the father allowed them to do so? I felt myself that two young adult lions and four young adult lionesses from different family groups in the Gir Forest might be the best answer. And then let them sort themselves out in their new home.

This problem was referred to several authorities on wild life in Africa, and the following replies have been received. Keith Caldwell, late of the Kenya and Uganda Game Departments, writes: 'I am strongly of the opinion that re-stocking should be done, if at all possible, by moving one or more complete families. I don't think there is any danger of damage being done by 'inbreeding' and I fancy that, as they grow more mature, the family will split up. The ideal would I think be two families. If two young males and four females are moved may I advise that they are all taken at the same time and let out together. If this is done they are far more likely to settle down without fighting than if they are liberated in their new homes at different times in different places. In this latter case serious battles are most likely to take place when the wanderers meet each other !'

C. R. S. Pitman, formerly Game Warden of Uganda, writes to say that he agrees with the suggestion of 'two young adult lions and four young adult lionesses from different family groups'. R. Bigalke, Director of the National Zoological Gardens of South Africa, writes: 'I favour the plan of taking two lions and four lionesses from different groups.'

R. A. Critchley, President of the Game Preservation and Hunting Association of Northern Rhodesia, writes: 'We, ourselves, think 2 young males and 4 females is the best combination.'

M. H. Cowie, Director of the Royal National Parks of Kenya, in an interesting letter on the subject of moving lions into a new locality, considers that it should be done in two distinct phases as follows: *First Phase.* One adult lion, at least two adult lionesses, and as many of their half-grown cubs as possible should be moved. It does not matter if the animals are related. If more than one adult lion is moved, they are likely to fight and disrupt the pride. *Second phase.* When the half-grown cubs have grown up and start hunting and courting, then a second adult lion should be introduced, if possible more virile than the first one, so that it can take over domination of the young pride. The old lionesses are likely to accept the original lion, while the young lionesses are likely to prefer the newly introduced lion. This will give the required new blood.

After carefully analysing the above opinions from experts on lions and conditions in Africa, the following would appear to me to be a safe summarisation of the principles which might govern the moving of lions in India:

(i) Only one adult lion, preferably a good maned specimen, should be moved with the first 'batch'.

(ii) The first 'batch', in addition to the adult lion, should include two lionesses, and if possible some of their half-grown or three-quarter grown cubs (preferably female).

(iii) All the above animals in the first 'batch' should be released at the same time and in the same place, with live food tied up for them.

(iv) At a later stage, when the grown-up cubs (either introduced with the first 'batch' or born subsequently) start to hunt and court, a second adult virile and maned lion should be introduced.

SPORT AND WILD LIFE PRESERVATION

It is important that we should recognise the exact status of the sportsman when considering measures for wild life preservation in India. By 'sportsman' I mean, of course, the *bona fide* sportsman who not only scrupulously observes the game laws and shooting rules in respect of close seasons, protected animals, reserved forests, and so on, but who also shoots only a limited number of game birds and animals. The so-called 'sportsman' who is a butcher, or who is in any way unscrupulous, is a menace to wild life conservation almost as much as the poacher is.

It is universally admitted by all those concerned with conservation of wild life throughout the world that the *bona fide* sportsman is one of the best friends of wild life. For by occasionally tracking and shooting game within the law, he becomes well versed in jungle lore and jungle craft and develops a knowledge and love of wild animals and birds not always obtainable by the man who is purely an observer or naturalist. The *bona fide* sportsman who later in life gives up all shooting for the camera, binoculars, and notebook is usually one of the ablest protagonists of wild life conservation.

It is universally admitted, also, that the presence of a *bona fide* sportsman in a forest is the most effective deterrent against poachers. Obviously no sportsman who has paid for and taken out licenses, permits, and reservations in a Forest Block is going to tolerate any kind of interference from poachers during his shoot. And even if there has been any poaching previous to his shoot he will soon hear about it and 'raise hell'. For this reason poachers usually give sportsmen a very wide berth. And for this reason many experienced sportsmen all over India have been made Honorary Forest Officers in order to assist the Forest Departments of States in the preservation of wild life.

At the meeting of the Executive Committee of the Indian Board for Wild Life held at Ootacamund in May 1955 it was agreed that Game, Shooting, and Fishing Associations play a very important role, and that real sportsmen in any area are an asset in the preservation of wild life. Consequent upon this, the Secretary of the Board in October 1955 addressed a letter to all Heads of State Forest Departments to the effect that Game Associations and Natural History Societies should be encouraged.

And yet, in spite of all the foregoing evidence that *bona fide* sportsmen are an asset to the country in general and to the Forest Department in particular, how often do we hear of sportsmen being rebuffed, of sportsmen receiving no replies to their letters, of sportsmen not being issued with shooting and fishing permits after payment of the usual fees! Worse still, many sportsmen and naturalists have written helpful reports about poaching, bombing of rivers for fish, and other illegalities to the Forest Officers concerned, and have received not only no thanks for their efforts, but not even an acknowledgement!

It is essential to preserve the wild life outside as well as inside our sanctuaries and national parks; and no real progress can be made in India until full encouragement and recognition is given to genuine sport and genuine sportsmen throughout the country.

'HIDES' FOR WILD LIFE PHOTOGRAPHERS

Much has been written by eminent bird photographers on their technique and on the types of photographic 'hides' used by them; but very little has been written on 'hides' for animal photographers. Nowadays roughly three out of every four visitors to a wild life sanctuary or national park carry a camera of some kind. They obviously want photos of wild life, and this requirement of visitors must be satisfactorily met if the wild life tourist trade in India is to be efficiently developed. And yet very few of the staff of our sanctuaries understand even the elementary requirements of an average photographer.

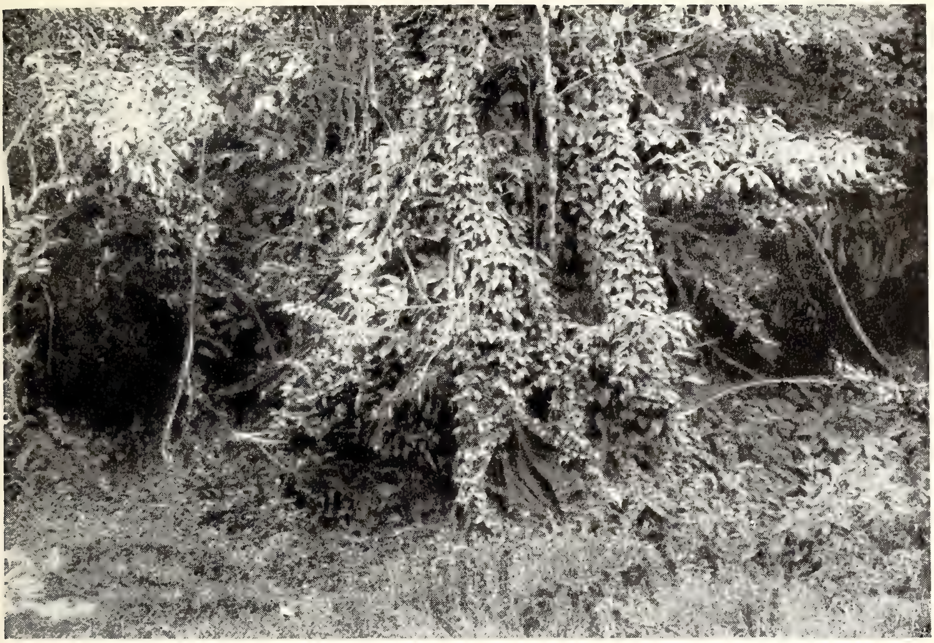
A few generalisations, therefore, on the subject of photographic 'hides' would not be out of place in this paper. Visitors can usually obtain some photographs from a motor car or riding elephant. But if more time is available, most visitors would welcome a quiet pleasant day or half day in a 'hide', especially if the 'hide' overlooks a water-hole or salt-lick. From such 'hides' wild animals can be observed coming out and towards one, instead of running away as they usually do when they see a human being. A glimpse can be obtained of them behaving naturally, feeding, drinking, courting, and so on.

I have seen 'hides' specially made for photographers in Kaziranga, Hailey National Park, Kanha, Bandipur, Gir Forest, and other places. They were all made by the Forest Department with the best of intentions, but from most of them no good photos could possibly have been taken. Some were sited in unsuitable places from where wild life would be far too far away, if seen at all. Some were fixed in trees as high as 25 ft. or 30 ft. from the ground, and from these only a bird's eye view of wild life could have been obtained. Some were admirably set up on the ground, but were too thick, possessed no peep-holes through which the photographer could see, and the branches and vegetation had not been cleared in front.

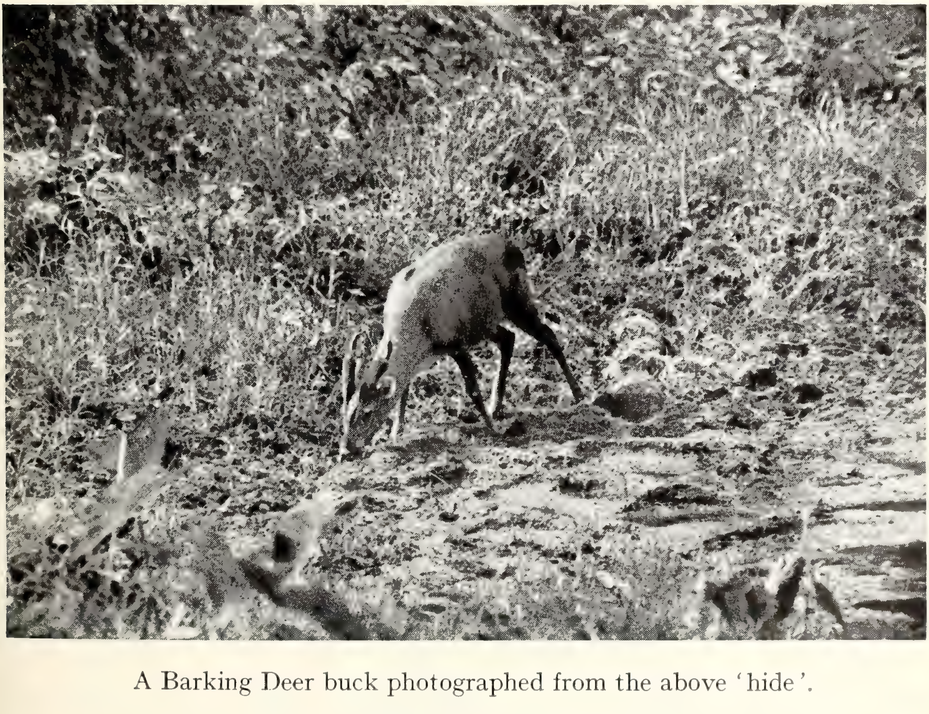
The first requirement of a photographic 'hide' is that it must be as close as possible to where an animal is likely to appear. Even with a 13.5 cm. telephoto lens and a 35 mm. camera, a *chital* would appear quite small at 60 ft. It would make a better picture at 30 ft.

The next requirement is that a 'hide' must be as low as possible to the ground while still giving a clear view of the subject. Animals photographed from elephant-back, when the camera lens would be about 12 ft. or 15 ft. above the ground level, would have a semi-bird's-eye-view appearance. If the undergrowth and grass permit, a 'hide' constructed on the actual ground would be the best, so that the camera lens would be about 3 ft. or 4 ft. from the ground. If there is too much undergrowth and grass, then the lowest height possible in order to see over the vegetation in front would be the best height to photograph from, say 6 ft. to 10 ft. Above that height one would get a picture in which one is looking too much down on the animal.

On the other hand, where there are dangerous animals about, such as rhinoceros, rogue elephant, man-eating carnivora, and so on, then the 'hide' would have to be either protected by a ditch 7 ft. wide all round it (for rhino and elephant), or placed in a tree just out of reach of the dangerous animals, say 15 ft. up. In this respect however, wild animals in general need not necessarily be regarded with fear by photographers. Wild animals very rarely attack a human unless provoked to do so. Theodore Hubback (1939) wrote of his photographic experiences in ground-level 'hides' in the Malayan jungle: 'I never think of taking a firearm with me into a "hide" and none should be permitted to do so'.



A portable 'hide' of hessian cloth, camouflaged and in position at a salt-lick.



A Barking Deer buck photographed from the above 'hide'.

(*Photos : E. P. Gee*)

The next requirements of a photographic 'hide' is that no branch, twig, leaf, blade of grass, and so on should be left uncut in the direct line of vision between the camera lens and the subject to be photographed. Although a human being looking with two eyes (set 3" apart) at a deer, say, will see the deer quite clearly in spite of a few intervening twigs or leaves, yet the single lens of a camera will faithfully record every twig and every leaf which happens to be in the line of vision, the nearer the bigger, and the resultant photo will be spoilt. A few twigs, leaves, or grasses near the animal itself are all right, in fact these would make the subject appear more natural; but anything nearer between the subject and the lens of the camera is to be avoided at all costs.

The next requirement of a 'hide' is that it must appear unobtrusive and natural. This can easily be done by camouflaging the 'hide' so as to make it appear part of the surrounding landscape and vegetation.

The size of the 'hide' is a minor detail, depending on how many people with how many cameras will remain inside it, and for how long. Generally speaking, the smaller the 'hide' the better and less conspicuous it will be.

The choice of materials for making a 'hide' also depends on the time available and the place in which it is made. Obviously the materials of the locality should be used, leafy branches in forest, grass in grassland etc. As little disturbance to the place as possible should be caused.

A disadvantage of using vegetation or grass to construct a 'hide' is that it will wither, shrink and change colour. Also the breeze can dislocate a leaf or a twig which would then interfere with the field of vision. To overcome these drawbacks I myself have a portable 'hide' made of hessian cloth dyed a suitable shade of green, with bamboo poles to hold it up, and with rectangular slits through which photographs can be taken. These slits must be horizontally rectangular to allow for lateral movement of the camera and for the view-finder and range-finder as well as the lens of the camera to function properly. This portable 'hide' can be quickly set up in a suitable position behind grass or undergrowth or creepers, and when finally fixed appears almost invisible.

The top must be covered over, not only to keep out the rain and bird droppings, but also to prevent birds and monkeys from observing one inside the 'hide' and then giving the alarm.

The direction of one's approach to the 'hide' must be carefully worked out whenever possible, so that it can be screened to allow one to enter one's 'hide' unobserved by the subject. The path can be swept of dry leaves and twigs to ensure a silent approach. A well-known device is this: if two persons are going to sit up in the 'hide', then about four or five persons can go to it, the two remain when all is ready and the others return. Any wild life watching the proceedings will be led to think that all have returned and that no one is about.

Another great advantage of having a photographic 'hide' on or near the ground is that it cannot be used by poachers for illicit shooting. A *machan* type of 'hide' in a tree would have to be dismantled after use or else carefully watched in case poachers used it. A possible precaution against the use of such tree-top 'hides' by poachers would be to have it in the form of a 'cage' with a lock-up door and a sharply apexed roof so that poachers could not sit up on top of it.

A type of 'hide' worthy of trial where dangerous carnivora may exist is a portable or transportable cage with detachable sides, large enough to hold two or three persons when placed in position on the ground. If constructed of bars of aluminium or some light alloy, the photographer could transport it to a suitable place and safely remain inside to do his photography. Such a cage, I understand, is now being tried out in Kotah for tiger photography.

The possibility of constructing (in suitably dry terrain, of course) an underground 'hide' near a water-hole or salt-lick should not be ignored. The Warden of Amboseli National Reserve in Kenya was planning to make one near Ol Tukai water-hole for viewing elephants and rhino at close quarters when I was there in 1954.

If no convenient water-hole or salt-lick exists in a sanctuary, there is no objection to constructing an artificial one at a suitable place. The most famous 'hide' in the world was the former Tree-tops House at Nyeri in Kenya, which was built near an artificial salt-lick.

In the siting of 'hides' the following considerations should be taken into account: (i) direction of the prevailing wind, so that wild animals coming out will not get wind of the hidden photographer, (ii) the direction of the sun, so that it will not shine directly into the camera lens and so that animals coming out will be in good light, and (iii) the background and foreground should be as photogenic as possible.

Whenever expert or experienced photographer visitors come to a sanctuary, their methods and technique, and their praise or criticism of the facilities provided for them should be studied, in order that improvements and new developments in this field can be made.

If photographic 'hides' on the above lines could be provided in India's wild life sanctuaries and national parks for photographer visitors, it would add considerably to their attraction and international status.

CONCLUSION

In this paper much emphasis has been placed on the need for the management and development of India's wild life sanctuaries and national parks for tourists and visitors. This is not due to any desire on my part to commercialise wild life; rather it is the result of recognising some of the land and population problems confronting India and the rest of the world.

Unless we can produce evidence of the economic or tourism value of our wild life sanctuaries, the other values (aesthetic, recreational, scientific, and biological) may not be sufficient to tip the scales in favour of their maintenance and continuance. Our statesmen, politicians, planners, economists, and others may give heed to the unwise ephemeral demands of unenlightened local interests, instead of considering the need for long-term planning and preservation for the benefit of the country as a whole.

Tourists from abroad and visitors from other parts of India coming to our wild life sanctuaries and national parks will bring revenue as well as the general realization of the value of our wild life. This revenue and this realization are both sorely needed to preserve for posterity a valuable but vanishing national asset.

REFERENCES

Champion, F. W. (1939): The Hailey National Park.

Chaturvedi, M. D. (1954): Save the Lion from Extinction. *Indian Forester,* **80** (12).

Dharmakumarsinhji, R. S. (1950): The Gir Forest and its Lions, Part II. *JBNHS,* **49** (3).

— — — (1954): Report of the Regional Secretary for Wild Life, Western Zone.

Fenton, L. L. (?): The Rifle in India.

Gee, E. P. (1952): The Management of India's Wild Life Sanctuaries and National Parks, Part I. *JBNHS,* **51** (1).

— — — (1955): The Management of India's Wild Life Sanctuaries and National Parks, Part II. *JBNHS,* **52** (4).

Hubback, Theodore (1939): Wild Life Photography in the Malayan Jungle. *JBNHS,* **41** (1).

Indian Board for Wild Life (1955): Indian Wild Life Bulletin, 2 (1).

— — — (1955): Indian Wild Life Bulletin, 2 (2).

Petrides, George A. (1955): A Report on Kenya's Wild Life Resources and the National Parks.

Pocock, R. I. (1939): The Fauna of British India, Mammalia Vol. I.

Singh, Kesri (1956): Experiments in Implanting African Lions into Madhya Bharat. *JBNHS,* **53** (3).

Wynter-Blyth, M. A. (1949): The Gir Forest and its Lions, Part I. *JBNHS,* **48** (3).

— — — (1950): The Gir Forest and its Lions, Part II. *JBNHS,* **49** (3).

— — — (1956): The Lion Census of 1955. *JBNHS,* **53** (4).

NOTES ON SOME WASPS AND BEES (HYMENOPTERA) OF POONA AND THE WESTERN GHATS

BY

F. L. WAIN, S.S.J.E.

(With a plate and 21 figures)

The following notes are based on a somewhat desultory collection made during the past five years. The nomenclature is that of Fauna of British India series (Bingham).

Wasps can roughly be distinguished from Bees, as being less hairy and not having the broad dilated joint on the hind legs which bees use for carrying pollen. Wasps are carnivorous in the larval stage, whereas bee grubs feed on honey and pollen. In the adult stage both Wasps and Bees are vegetarian. Both groups contain social and solitary forms.

WASPS

Wasps are divided into two main groups, the Hunting or Digging Wasps (Fossores) and the True Wasps (Diploptera). The latter fold the wings lengthways in two when at rest.

FOSSORES

The females of these wasps hunt for prey of various kinds on which to lay their eggs. The prey is stored up in various ways, usually alive but paralysed by being stung, to ensure the grub shall have fresh meat for its food and not be poisoned by eating decayed food.

Family MUTILLIDAE

The females are without wings, and at first glance look something like ants ; but they move much more quickly. They are said to lay their eggs on the larvae of various kinds of bees.

Mutilla argenteomaculata ♀. About three quarters of an inch long, with six silver spots on the black abdomen. (Khandala).

Mutilla pulchiventris ?♀. Less than half an inch, with five silver spots. (Poona).

Mutilla valida ♀. Same size as above with four spots. (Lonavla).

Mutilla nobilis ♀ (Fig. 1). Head and thorax red, abdomen with golden spots. (Lonavla).

Mutilla emeryi ?♂. Orange red abdomen. (Matheran. Lonavla).

Family Scoliidae

These are usually heavily built hairy wasps. They make no nest, but the female burrows in the earth to find beetle larvae, on which the eggs are laid. They can sometimes be seen entering heaps of decaying leaves in search of the large fat white beetle grubs. These wasps are often found at flowers.

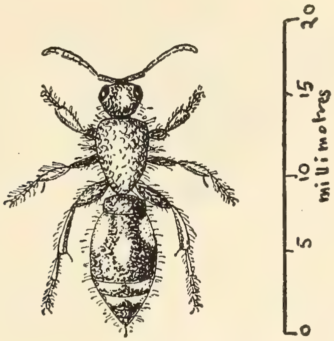


Fig. 1. *Mutilla nobilis* ♀

Scolia bilunata. Black, with four yellow spots on sides of the abdomen. The male is slighter with three spines on end segment. (Poona).

Scolia quadripustulata (Fig. 2). Black with red spots or band on the abdomen. A very common species. (Poona. Khandala).

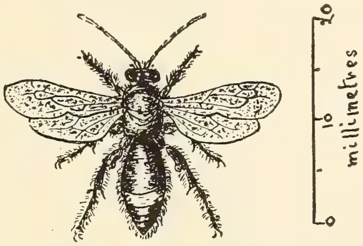


Fig. 2. *Scolia quadripustulata* ♂

Scolia aureipennis. Entirely black, with a coppery sheen on the wings. Tips of the antennae red. (Poona).

Scolia histrionica. Strikingly coloured in red and yellow, with some black markings. (Poona).

Elis thoracica (Fig. 3). Black, with thick whitish hair on the thorax. I have seen this wasp burrowing in loose earth, but when I dug out the earth only two crickets were found. I could not find any beetle larvae. (Poona. Khandala).

Elis annulata ♂. I have only found males. Smallish, black with yellow bands. (Poona. Matheran. Lonavla).

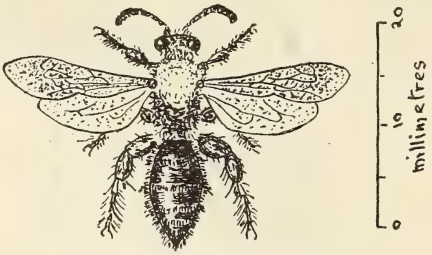


Fig. 3. *Elis thoracica* ♀

Elis asiatica ? A large entirely black wasp. (Poona).

Liacos analis. Black, with most of abdomen bright red. (Matheran).

Family POMPILIDAE

These wasps have very long legs; the abdomen is never on a long thin stalk, as in many of the Sphegids; the eyes are not kidney-shaped.

This group contains wasps of very varying size. Most store the prey in holes or crevices in walls or trees, or in the ground, though a few make little mud cells. The prey consists of spiders, crickets or grasshoppers.

Pseudagenia blanda (Fig. 4). This genus makes little earthen cells in which the prey (spiders) is stored. This wasp is about half an inch long, bright metallic blue. (Bombay).

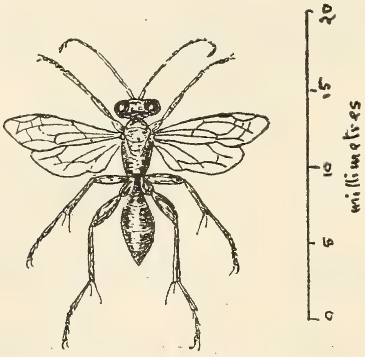


Fig. 4. *Pseudagenia blanda* ♀

Pseudagenia tincta. A small black wasp. (Poona).

Pseudagenia micromegala ? Another smaller black wasp, with two dark bands in the clear wings. (Poona).

Pompilus fenestratus. This genus preys on spiders and stores them in some nearby hole in the earth or crevice, blocking up the entrance afterwards with a small stone or earth. This species is very small, black with red abdomen. (Poona).

Pompilus mitis. Similar to the above, but larger. (Poona).

Salius aureosericeus. *Salius* contains some of the largest species of wasp. They prey on various kinds of Orthoptera. This species is a large insect, with a wing-spread of two and a half inches. It is black, with head and fore part of the thorax covered with golden hairs. The wings are deep yellow. It may have been this wasp (unless it was *Sphex luteipennis*) which I saw flying with a large green grasshopper held in its legs. It dropped the grasshopper and flew off before I could see it properly. (Matheran).

Salius fulvipennis. Similar to the above but smaller. Often seen in light forest. (Lonavla).

Salius flavus (Fig. 5). Rather smaller than *Salius fulvipennis*, with the feet black. (Poona. Khandala).

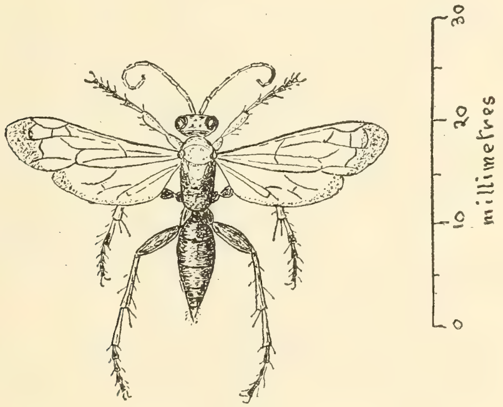


Fig. 5. *Salius flavus* ♀

Salius consanguineus. Black, with orange legs and dark purplish brown wings. (Matheran. Lonavla).

Salius madraspatanus (Fig. 6). A large wasp, velvety black all over, with dark brown wings, having a purple sheen. I saw this wasp as it captured a grasshopper about its own size. The wasp stood over its prey and stung it carefully on the underside of the thorax. The grasshopper was then quite paralysed. After cleaning itself up, the *Salius* took the prey in its mouth and dragged it along between its legs. It flew only occasionally in short flights of a few inches. The grasshopper was pulled up the trunk of a Banyan tree to the wasp's nest in a crevice in the trunk, quite high up. (Lonavla, Matheran).

Family Sphegidae

This is rather a heterogeneous group. They are distinguished by the first thoracic segment, which is short, like a kind of collar round the neck, and which does not reach back to the base of the wings as in all other wasps.

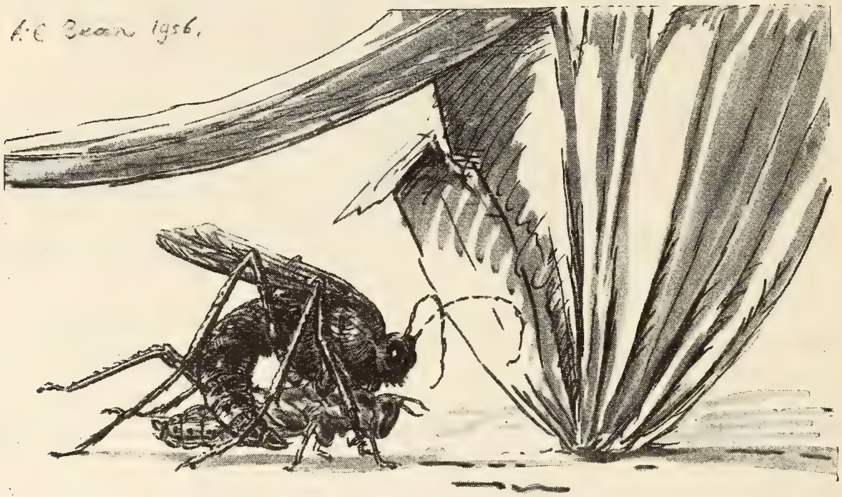

A.C. Bean 1956.

Fig. 6. *Salius madraspatanus* about to sting a grasshopper nymph.

Tachytes modesta. Black with lines of silvery pile on the abdomen. The legs reddish. *Tachytes* makes holes in the ground for nests and stores Orthoptera for the grub to feed on. (Poona).

Tachytes nitidula. Similar, but with legs black. (Khandala).

Notogonia subtessellata. A small black wasp, which also nests in the ground and preys on crickets. (Poona).

Liris aurata (Fig. 7). A beautiful little wasp, the golden pile on the head and prothorax being quite conspicuous. I have noted these wasps occupying a hole in a wall at nights for several nights in succession. It preys on crickets and stores them in nests underground. (Poona).

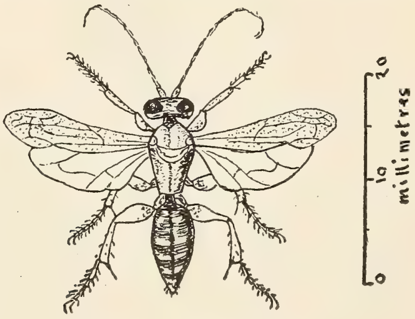


Fig. 7. *Liris aurata* ♀

Pison argentatum. A very small black insect, less than half an inch long. I think this is the wasp which builds small elliptical mud nests, many together, often in houses in the corners of ceilings and walls. (Poona).

Trypoxylon intrudens (Fig. 8). This also comes frequently into the house. It has a very long narrow tapering abdomen, reddish with black apex, which makes it fairly easy to identify at once. These wasps build mud nests, which I have always found singly, on walls of houses, indoors. They are oblong, and rough outside. They are stored with paralysed spiders for the grub. (Poona).

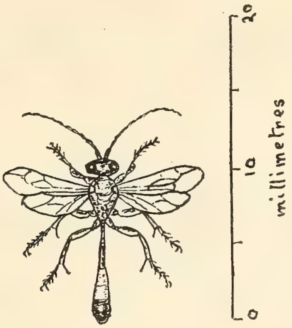


Fig. 8. *Trypoxylon intrudens* ♀

Trypoxylon bicolor. Similar to the above but larger.

Ammophila laevigata (Fig. 9). Another wasp with a very long petiole to the abdomen. At first glance it resembles *Trypoxylon bicolor*, but can be distinguished by the two apical spurs on the intermediate tibiae and the more complicated venation of the forewings. *Trypoxylon* has only one tibial spur and a comparatively simple venation. *Ammophila* nests in the ground and stores carterpillars or spiders. A nest of *Ammophila laevigata* I found was dug vertically in level fairly hard ground. I saw the wasp just as it had brought a green caterpillar, which lay rigid and paralysed some three inches from the nest hole. The wasp went down the hole two or three times, and

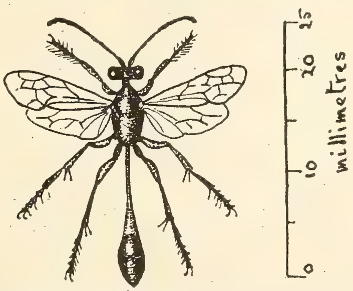


Fig. 9. *Ammophila laevigata* ♀

then, seizing the caterpillar by the head in its jaws, dragged it down the hole, the wasp going backwards. It then came up and proceeded to close up the hole. First a large flat stone was put over the mouth of the nest, then smaller ones, and finally dust swept over. The ground was made quite level and small stones and pieces of grass arranged over the top, so that no sign of the hole remained. (Poona. Lonavla).

Sceliphron madraspatanum (Fig. 10). Another wasp with a very long thin petiole to the abdomen. It is strikingly coloured in black with

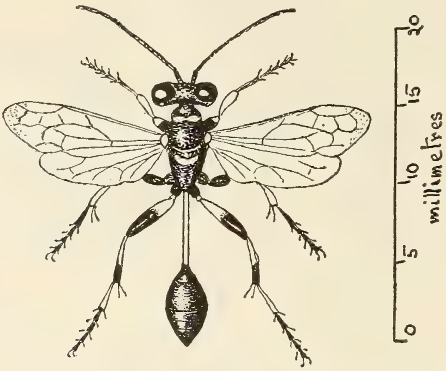


Fig. 10. *Sceliphron madraspatanum* ♂

yellow petiole and legs. *Sceliphron* makes cylindrical mud cells and stores them with spiders. A nest examined contained twenty three spiders. (Poona. Lonavla).

Sceliphron coromandelicum. Distinguished from the above by having the posterior legs yellow, without any black marks on them. I have noticed some of these wasps congregating together in the evenings on some branch or leaf, for several nights in succession. (Poona).

Sceliphron violaceum. Dark shining metallic blue all over. This species seems often to build the mud cell in a hole. I once saw one use the ventilation hole of a sola topi. It first widened the hole, bringing out bits of pith by the front legs. The nest was stored with spiders, carried by the front legs only, except one large one, for which the wasp used the front and intermediate legs. This large spider was carefully stung before being pushed into the nest. Five or six spiders were put in. The nest was then closed with mud, the pellets being carried in the mandibles. At first it was worked smooth, but the finishing coat was put on roughly and allowed to remain so. The whole process took two days, during which the removal of the topi at intervals did not seem to upset the wasp at all. (Poona. Matheran. Lonavla).

Sphex lobatus. All species of *Sphex* make nests in the ground and store them with various kinds of Orthoptera. This species is a large wasp, nearly one and a quarter inches long, brilliant metallic blue-green all over, with yellowish wings. In hunting for crickets, this wasp digs in loose earth like a dog, using the front and intermediate legs, and sending a spray of earth out behind. Large stones and sticks it removes in its mouth, walking backwards as it removes them. (Poona. Lonavla).

Sphex splendidus. About the same size as the above. The head, thorax and legs are brick red and the abdomen metallic purple. I have not noticed this wasp digging for prey, and it probably attacks grasshoppers. It frequents hard, stony, dry ground. (Lonavla. Sinhagad).

Sphex luteipennis. A very large black wasp with yellow wings. This may have been the insect I saw flying with the large green grasshopper, if it was not *Salius.* But I have seen it stated that *Sphex* always drags its prey along the ground. (Matheran).

Sphex umbrosus. Smaller: black with whitish pubescence on thorax. Wings transparent and colourless. (Poona).

Sphex aurulentus (Fig. 11). Reddish, with apex of abdomen black. A common species. (Poona. Matheran. Lonavla).

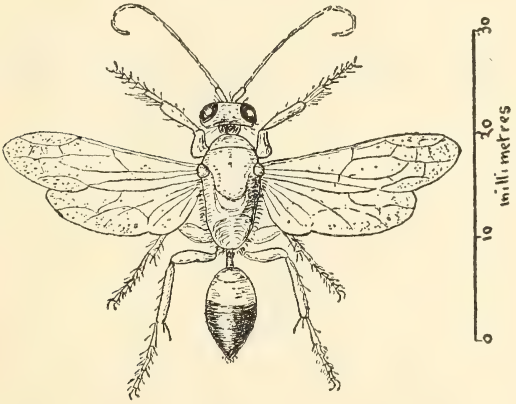


Fig. 11. *Sphex aurulentus* ♀

Sphex vicinus ? Smaller: black variegated with dull red. Also very common. (Matheran. Lonavla. Poona).

Ampulex compressa (Fig. 12). Shining metallic blue-green, with posterior legs red. It is characterised by a very long narrow pro-thorax. It preys on cockroaches and often enters houses in search of them. I have seen this insect with a cockroach it had just captured. It soon flew off however, perhaps as I was standing too near. The cockroach gradually recovered from its paralysis and after about fifteen minutes walked away. *Ampulex* stores its prey in a hole or crevice, blocking up the entrance. (Poona).

Trirhogma caerulea. Dark metallic blue, about half an inch long. Uncommon. (Poona).

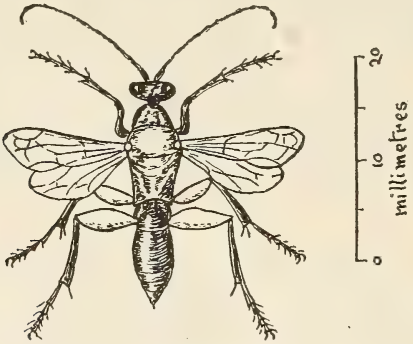


Fig. 12. *Ampulex compressa* ♀

Stigmus niger. A minute black wasp, less than one quarter of an inch long, with conspicuous stigma in the wing. It is often seen on the window pane in houses. (Poona).

Stizus blandinus. A rather heavily built wasp, black, with abdomen light brick red. In Europe a *Stizus* preys on frog-hoppers. (Poona).

Bembex trepanda (Fig. 13). Variegated yellow and black. *Bembex* is partially social, many individuals making their nest burrows in the same patch of sandy soil. It preys on flies, and is unusual in that the prey is killed, not paralysed. The nest is only temporarily closed and the mother wasp brings more flies for the growing grub as it needs them. The characteristic of this genus is the long prominent labrum, or upper lip. (Poona. Lonavla).

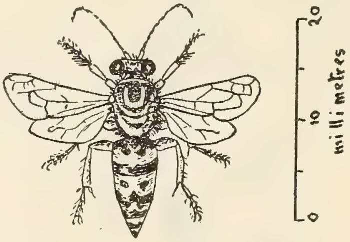


Fig. 13. *Bembex trepanda* ♀

Philanthus basalis. Small black wasps with yellow bands on the abdomen. The legs are reddish. Often found at flowers. They nest in holes in the ground, closing the entrance with loose earth. I have seen a small Chrysid wasp enter a nest, so presumably it parasitises the *Philanthus*. (Poona. Sinhagad. Lonavla).

Cerceris humbertiana ? A tiny wasp, black with yellowish markings, and the first segment of the abdomen red. The characteristic of this genus is the strongly constricted segments of the abdomen, as if tight threads had been tied round at intervals. *Cerceris* is said to prey on beetles. (Lonavla).

Oxybelus agilis. Another tiny wasp, with some whitish markings. (Poona).

DIPLOPTERA

Family EUMENIDAE

The True Wasps are divided into Eumenidae and Vespidae. The only constant feature which distinguishes them, is that the former have only one apical spur on the intermediate tibia, the latter have two. Eumenids are solitary wasps ; Vespids are social.

Eumenes petiolata (Fig. 14). A large red wasp, with long narrow petiole to the abdomen, which is yellow, with a black band. All this genus make beautiful little clay nests, shaped like an earthenware 'chatti', complete with rim. They store them with caterpillars, closing the cell and usually plastering the whole over roughly with mud, so that the 'chatti' is no longer seen. (Poona).

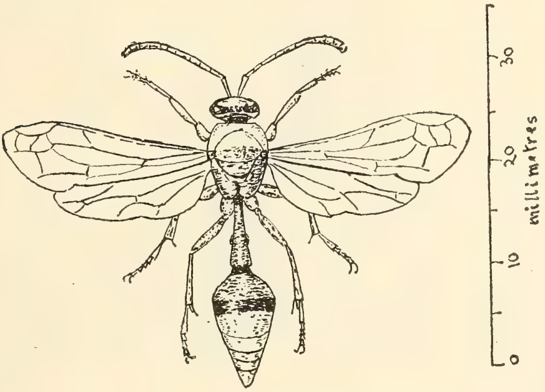


Fig. 14. *Eumenes petiolata* ♀

Eumenes affinissima. Small and black with a few yellow markings. All *Eumenes* have the long narrow petiole. (Poona).

Eumenes esuriens. Like *Eumenes petiolata*, but half the size. (Poona).

Eumenes conica. Large, red, with black markings. This wasp often enters houses in order to build its nest. It is frequently parasitised by a Chrysid wasp, *Stilbum cyanurum*, bright metallic green which may often be seen in the house searching for *Eumenes*' nests. (Poona).

Eumenes flavopicta. Large, with very long thin petiole; yellow and black bands. (Matheran. Sinhagad. Lonavla).

Rhynchium brunneum. *Rhynchium* differs from *Eumenes* in not having the long petiole. This species is dull red with black markings. It often enters houses in order to make its nest in some hole in the furniture. It lines the hole and closes it with mud. It stores caterpillars, which I have seen it bring to the nest flying, held under the body by the six legs. (Poona).

Rhynchium metallicum. Jet black all over. (Poona).

Rhynchium nitidulum. Only to be distinguished from the above by the curious projections from the sides of thorax. (Poona).

Odynerus ovalis (Fig. 15). A small black and yellow wasp with no petiole. It makes its nests in the perpendicular banks of streams or ponds. The nest is at the end of a short tunnel, at the entrance to which it constructs a fragile earthen tube, hanging downwards. I have seen it stated that these bent tubes discourage parasites from entering. *Odynerus* stores caterpillars for the grub. (Poona. Lonavla).

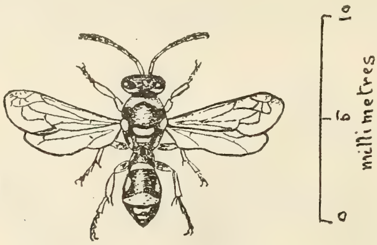


Fig. 15. *Odynerus ovalis* ♀

Odynerus miniatus. A tiny wasp, smaller than the above. (Poona).

Family VESPIDAE

These are the True Social Wasps.

Icaria marginata. Very common. A small red wasp. They make the nest of 5–40 cells, of wasp-paper. The cells all open downwards and are attached by a strong 'stalk' to the underside of leaves, branches etc. They often build in houses. A distinguishing character of *Icaria* is the very retractile end segments of the body, which are usually folded into the large bell-shaped second segment in telescope fashion.

Icaria ferruginea (Fig. 16). Larger than the above, red with broad yellow band on abdomen. (Poona. Purandhar).

Icaria variegata. A common tiny red wasp with yellow and black markings. (Poona. Lonavla).

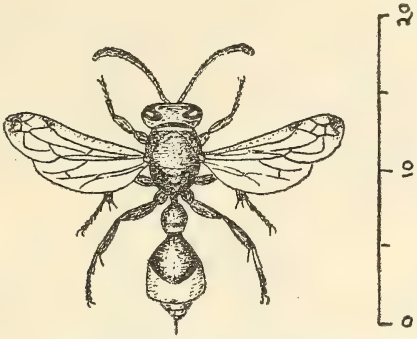


Fig. 16. *Icaria ferruginea* ♀

Polistes stigma. *Polistes* has no petiole as *Icaria* has. (Poona. Lonavla).

Polistes hebraeus (Fig. 17). Large yellowish, with some black markings. (Poona).

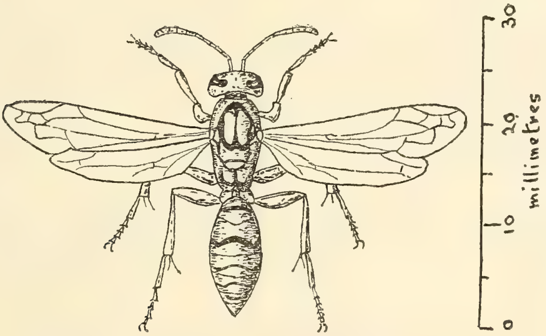


Fig. 17. *Polistes hebraeus* ♀

Vespa cincta. A large wasp with conspicuous yellow band round the abdomen. The sting is said to be dangerous. (Poona. Lonavla).

BEES

Nomia westwoodii. A small black bee, one-third of an inch long with greenish yellow bands on the abdomen. A solitary bee, nesting in tunnels in the ground. (Purandhar).

Megachile disjuncta. *Megachile* comprises the Leaf-cutter bees. They line their nests with pieces of leaf which they cut in the following way. The bee sits on the edge of a leaf, the legs holding it on either side. It then begins to cut in a semicircle towards its tail.

As the cutting goes on the piece of leaf is rolled up between the legs. As the last cut is made, it flies off with the cut piece rolled up between its legs. They nest in holes, often in houses; some make mud cells. I found one nest, put among the roots of a fern, made entirely of rose petals. The nest is filled with honey and pollen for the larva. *Megachile disjuncta* is black with a conspicuous yellow band round the waist. (Poona).

Megachile lanata (Fig. 18). Bright rusty red hair on the head, thorax and top of abdomen. The rest of the abdomen with thin white bands. A common species, which often enters houses to nest. It makes mud cells. (Poona. Lonavla. Sinhagad).

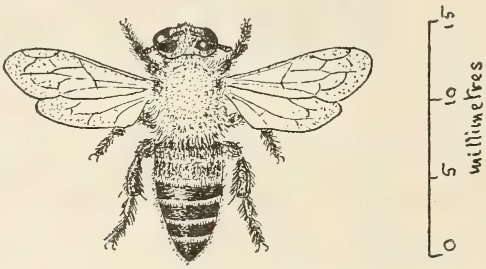


Fig. 18. *Megachile lanata* ♀

Megachile cephalotes. A small black bee, with thin whitish bands on the abdomen. (Poona).

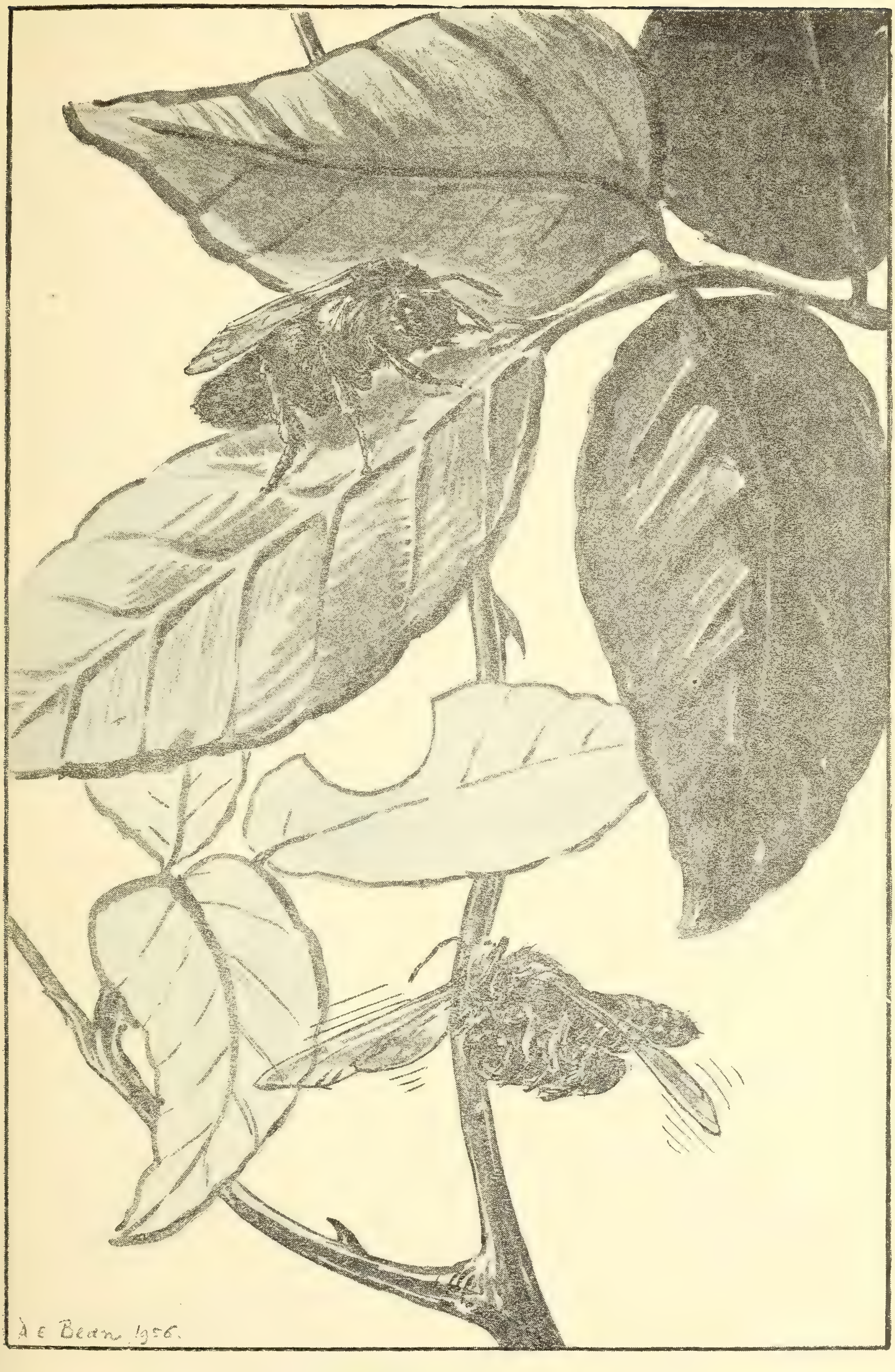
Megachile albifrons. Black, with snow white pubescence on head, sides of thorax and bands on the abdomen. (Sinhagad).

Parevaspis carbonaria. A black rather hairless bee with darkish wings. It is parasitic on *Megachile.* (Poona).

Ceratina viridissima. A tiny bright metallic green or blue bee. Common at flowers. They are said to nest in hollow stems. (Poona. Sinhagad. Lonavla).

Coelioxys decipiens. Black, with white markings and bands on the abdomen. The abdomen is rather long and, remarkably pointed, shaped somewhat like a carrot. These bees are parasitic upon *Megachile.* (Poona).

Crocisa emarginata. *Crocisa* is parasitic in the nests of *Anthophora* and can often be seen examining walls or banks for the nests. This species is black with markings and bands of a beautiful bright blue, varying in shade. (Poona. Matheran).


A E Bean 1956.

Leaf-cutter Bees *(Megachile disjuncta)* in action.

Crocisa ramosa (Fig. 19). Another beautiful bee, jet black with snow-white spots. (Poona. Sinhagad).

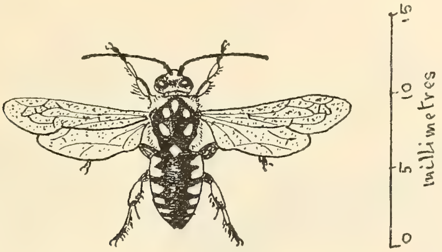


Fig. 19. *Crocisa ramosa* ♂

Anthophora zonata (Fig. 20). Stoutly built bees, with bright shining blue bands on the abdomen. *Anthophora* have remarkably long tongues.

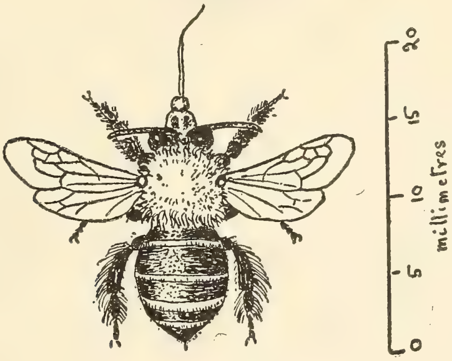


Fig. 20. *Anthophora zonata* ♀

They fly very rapidly and are also often seen hovering quite still in front of flowers. They are gregarious, nesting in holes in steep banks or in walls, many together; but they are not truly social. (Poona. Sinhagad. Lonavla).

Anthophora fallax. Rather smaller than the above, with white bands. (Poona. Sinhagad).

Xylocopa dissimilis. These are the Carpenter Bees, which excavate holes in wood to make their nests. I have seen nests in the beams of house roofs and in bamboo poles. The mandibles must be immensely strong, as they bore beautifully neat holes in the hardest wood. This species is a large black bee, one and a quarter inch long with irridescent wings. (Poona. Lonavla).

Xylocopa latipes (Fig. 21). Another large black bee. The male has curiously flattened front legs, yellow and fringed with long thick yellow hairs. (Lonavla)

Xylocopa amethystina. Black, but about half the size of *Xylocopa dissimilis.* (Poona).

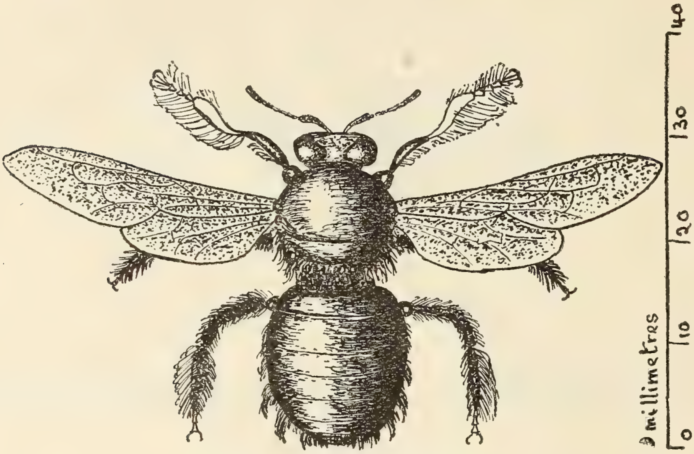


Fig. 21. *Xylocopa latipes* ♂

Xylocopa aestuans. Black, with bright yellow thorax. (Poona. Matheran).

Xylocopa rufescens. Brown, with golden brown thorax. (Bombay).

Apis dorsata. *Apis* comprises the honey bees and are social, the communities consisting of a single fertile female or queen, workers and males. This species is the large Rock Bee which places its combs in the open, under eaves of roofs, on the under side of branches, or under overhanging rocks. (Poona. Lonavla).

Apis indica. In the wild state, it nests in hollow trees, holes in walls, or even abandoned white-ant mounds. It has been successfully domesticated, and takes readily to hives. (Poona. Lonavla).

Apis florea. The smallest of the *Apis* genus. It places its combs in the open, in trees, or bushes, or in creepers on the sides of houses. It is very common in the district. (Poona. Lonavla).

Melipona iridipennis. Sometimes called 'Mosquito bees'. They are social and are tiny black bees, hardly one quarter inch long, often seen at flowers. For the size of the bee, they carry enormous loads of pollen on the hind legs. I have found nests only in holes in walls, the entrance usually very narrow and sometimes with a curious trumpet-shaped tube of wax projecting. The tubes I have seen were about one inch in diameter at the end and projecting only about two inches. (Poona).

My thanks are due to the Rev. A. E. Bean, S.S.J.E., for the action drawings.

DUCKS UNLIMITED:

AND WILD LIFE PRESERVATION IN CEYLON

BY

PHILIP K. CROWE

(*With a plate*)

Few non-hunters seem to realize that the survival of game in many parts of the world depends primarily on sportsmen; yet it is certainly logical to surmise that those who derive their greatest pleasure and relaxation from shooting should be those who make the greatest effort to ascertain that their sport continues. Certainly many who do not shoot have contributed greatly to the preservation of wild life but, in most countries where protection exists today, the generosity and interest of the hunters have exerted the major pressure to save the game.

Take ducks in America. Fifty years ago countless millions of wild fowl filled the skies as they winged across the United States to and from their breeding grounds in Canada. 'There will always be ducks' said the hunters and the ornithologists. Then suddenly, in the twenties, the migrations fell off alarmingly. The Wild Life Service estimated that not more than 30 million ducks were left out of an estimated normal of 200 million. The great banners of waterfowl that used to wave across the skies had shrunk to tattered ribbons. Something had to be done and done quickly.

The sportsmen met the challenge. A small group, headed by Joseph P. Knapp, formed the 'More Game Birds in America Foundation' and hired 2,000 biologists and observers to conduct an International duck census. The result of this survey revealed that the trouble lay not in over shooting but in the breeding grounds. Draining of the Canadian marshes, to plant wheat to meet the needs of a hungry world during two world wars, was having its baleful affect on the wild fowl population

The survey estimated that 70 per cent of the prospective North American duck population died on these far northern breeding grounds, and that nearly 90 per cent of all the ducks that flew over the United States were bred in these same marshes. Only 23 million acres of land in America was considered good breeding territory for ducks while Canada had 640 million acres. In the vast wet lands of Alberta, Manitoba, and Saskatchewan lay the Continent's 'duck factory'. The answer obviously was in Canada but, in 1937, there was no way in which U.S. Government funds could be spent in another country to improve waterfowl breeding grounds; the job had to be done privately.

At the foundation meeting set up in Washington, the matter of a title for the organization was brought up and 'Ducks Ltd.' was suggested. 'Limited, hell!' said one outspoken member, 'what we want is ducks unlimited'. And ten days after incorporation, 'Ducks Unlimited', financed by American and Canadian sportsmen, started its first big project, the restoration of 50,000 acres in Big Grass Marsh in Manitoba. There was no time in those pioneer days for permanent dams; the earth was pushed with bulldozers, holes were blasted in the prairie to hold water. Without water the ducks died. Everyone helped. The Canadian Provincial Governments turned over 60 million acres of poor wheat land; thousands of farmers promised cooperation. One dour old Scotch wheat farmer said 'Dead ducklings ruin my hay', and then his face softened and he added 'I sort of like the living things on my land.'

While these first dams were being built, reports from the field showed that other causes besides drought were cutting down the flocks. Crows and magpies devoured 15% of the eggs; fires destroyed another 12%; so did Indians, skunks, coyotes, wolves, squirrels, and jackfish. In fact, these great northern pike were estimated to consume 8 million ducklings a year! 'Ducks Unlimited' attacked the enemies on all fronts. Wire nets kept out the fish; a bounty was placed on crows and magpies; and the Indians were persuaded to give up eating duck eggs by giving them funds to buy other food they liked better. Even beaver were imported to build their water-holding dams and give the Indians a better living from trapping. Today the record is impressive. 'Ducks Unlimited' has established 3,000 miles of shoreline nesting areas; built 614 dams; banded 70,000 ducks and geese; planted thousands of aquatic plants; and maintains 600,000 acres of water on the prairie provinces of Canada.

All this has cost money, more than $5,000,000 to date, and it has all come from duck hunters. Have the results justified this expenditure? By 1947, ten years after 'Ducks Unlimited' started functioning, the duck population had risen to 160 million and in every year, but one, an increase has been noted. This year's census will probably show that the total is again approaching the norm of 200 million ducks, which the scientists think is about the right number for the continent to carry.

The interesting fact about this recovery in America's duck population is that it has taken place *in spite of a greatly increased number of hunters.* Moreover, more than 2 million duck licenses are issued yearly in the United States, a four-fold increase since 1934, and if these license-holders and the generations after them are to find sport in the skies more money must be raised to open up new breeding grounds in the north country. It is a challenge that Ducks Unlimited, financed by the sportsmen of America, is willing to face.

Here in Ceylon we also face a crisis in the Island's wild life. According to Major W. W. A. Phillips, one of the Island's leading authorities, the last half century has seen great changes in the status and distribution of the Island's unique wild life; some notable forms are already extinct, or verging on extinction, and others have been sadly depleted in numbers and restricted in range. He predicts that the next half century will undoubtedly see the extinction of many valuable species.

Not all of these species can be saved but a concerted effort by the sportsmen of Ceylon could go a long way towards aiding the government to preserve many of those birds and animals which provide the hunter with his happiest hours. An organization dedicated to protecting the Island's wild life already exists, The Ceylon Wild Life Protection Society, but it lacks funds and the whole-hearted support of the sportsmen. Some people seem to think, in fact, that the Society is opposed to legitimate sport. This is not the case. No one knows better than the members of the Society that the animals shot under license in the government preserves constitute but a minute fraction of the numbers killed illegally.

Ducks Unlimited : Scenes in the Grey Lodge Wildfowl Refuge, California.

(*Photos : Sálim Ali*)

So far, however, the Society has made no real effort to attract and organize the Island's sportsmen.

Even for many of Ceylon's rigidly protected fauna the end seems near. The most dramatic and tragic example of approaching extinction is provided by the Ceylon elephant. At the beginning of this century, it was estimated that at least 2,000 of these great beasts roamed the Island's jungles. Then, the herds migrated into the hills during the dry season and elephant paths could be seen along the ridges of the mountains. There was even a small resident herd in the Horton Plains area. Today, experts say there are less than half this number left and they declare that, since the rate of depletion by killing and capturing is about twice the normal rate of increase, the writing is on the wall for Ceylon's noblest animal unless draconian steps are taken immediately to save it.

Two forms of our wild life are already virtually extinct. The Ceylon Hog-Deer, which used to be plentiful in the Galle area, has vanished. Pressure of population to open new lands to cultivation has driven this interesting little deer from the coastal area and, since it was apparently unable to survive in the inland hill country, it has been killed out. Another inoffensive mammal, the Dugong, has become so rare in the shallow seas of the Mannar area that for all practical purposes it is also extinct. Major Phillips thinks that, even with strict protection, it is now doubtful if this unique species, from which the ancients drew their tales of mermaids, can recover. Several years ago I saw one swimming in a tank of turtles and offered to purchase it in order to set it free. The fisherman who had netted it told me, however, that there would be no use in this gesture as it would immediately be caught by someone else. Sluggish and trustful, the Dugong seems doomed.

The wild buffalo, protected from shooting by his resemblance to his tame brothers and a perpetual closed season, is still found in good numbers in the national parks, but illegal capture, for domestic use, has all but exterminated it in other areas. On a five day trip down the Mahaweli Ganga, which flows through one of the Island's few remaining isolated jungle areas, I saw only a few tracks of wild buffalo.

Spotted Deer and Sambar reproduce rapidly ; they are still plentiful, therefore, in the national parks and shooting reserves, but outside of these protected areas they are becoming increasingly rare. I have made many motor trips around the Island and have kept careful notes of all wild life seen. Even on the long stretches where the roads run through heavy jungle, as on the link between Puttalam and Anuradapura, and Anuradapura and Trincomalee, I saw pitifully few deer, and all of these during the day. Night shooting from cars has driven the surviving game deep into the forests. Lights on the road at night may mean death to them.

The deer are protected by law, however, and ostensibly derive some benefit from the closed season. No laws cover the Sloth Bear, Leopard, Crocodile, or Wild Pig. Outside the reserves, they can be shot the year round, and this indiscriminate slaughter goes on twelve months a year. In the Wanni I saw a she-bear with two cubs which a local ' sportsman ' had shot from a blind over a water hole. He said he had no use for the skins, could not afford to mount the heads, and had only shot the trio for fun. On another occasion I saw the skin of a leopard cub that would not cover a baby. The hunter who had shot it tried to sell it to me for a ' trophy '. Pig's flesh cannot be touched by Moslems but Moorish poachers frequently shoot pig to sell the flesh.

The sale of the flesh and skins of all wild life is prohibited by law but they can be bought in almost any village near a jungle area, and the vats of the government tannery in Colombo are always full of skins in and out of season. The Crocodile, which performs a useful purpose in cleaning up dead animals in the tanks, is now extinct outside the protected areas. Its belly skin sells for a price that makes the fine for selling it a minor hazard.

The primates have also suffered. The Grey Langur or Wanderoo, and the Red Monkey have been greatly reduced in numbers. There is some point in shooting the Red Monkey as it is very destructive to crops, but the big Langurs gain most of their sustenance from the jungle and are shot only by the Tamil labourers for their flesh.

The birds have also suffered. The peafowl, Asia's largest and most beautiful game bird, is continuously poached for its feathers, flesh, and oil. The ayurvedic belief that the oil, emanating from a peafowl's legs, is a specific for a number of diseases results in a constant illegal market for the unfortunate bird. Legitimate hunters kill only a few peafowl for it is an extremely wary and keen eyed fowl ; it takes a long, lucky shot to bag one during the day. At night, however, the big birds roost in trees and it is then that the poachers slaughter them as they huddle, silhouetted against the sky, in the moonlight.

The Painted Partridge, formerly plentiful in the Uva hills, is now virtually extinct except for small numbers in the country around Nilgala. Major Phillips believes that the extinction of this beautiful little partridge is not so much due to over-shooting, trapping, and egg-stealing as to the burning of the grass and patna lands. The Grey Partridge has also decreased alarmingly, and is now confined to the Mannar area and a few islands off the coast there. I had some good partridge shooting on Iranitivu but since then have heard that a party of market-hunters invaded the island and shot virtually every bird they could find. As the partridge cannot leave the island, the distance to the mainland being too great for them to fly, it would not be difficult to exterminate them.

The Comb-duck and the Glossy Ibis have gone completely from Ceylon. Occasionally, a straggler from India is identified but both of these rare and interesting birds have ceased to breed in the island's tanks. In 1880 the famous ornithologist, Legge, reported that Comb-ducks were fairly common in the north and east and about the same period Layard noted that the Glossy Ibis was seen in abundance in the north of the Island. Despite laws protecting them, Egrets, Herons, and Storks are being persecuted to a point where they too may face extinction. Unfortunately all these beautiful birds are edible, as well as providing fine feathers for the children.

Even eagles and other large raptores, whose flesh has no food value whatsoever, are shot by irresponsible hunters. The Rufousbellied Hawk-Eagle is virtually extinct and the numbers of Legge's Hawk-Eagle and the proud Whitebellied Sea Eagle are decreasing yearly. The Malabar Pied Hornbill, which looks like a bird from the pre-ice age and takes off slower than a heavy bomber, is now rare outside the reserves, and the Ceylon Broadbilled Roller can only be found in a few remote localities.

Blame for Ceylon's vanishing wild life is of course due to a number of factors of which the most important is probably the steady increase in the Island's population. In 1900 only 3½ million people lived in Ceylon. Today there are nearly 9 million and by 1980 it is predicted there will be

18 million. Ceylon's rate of increase, 2·8%, is the third highest in the world and is exceeded only by Venezuela and Panama. Pressure for food, from the increasing number of mouths, naturally results in opening up of more land to cultivation with an inevitable effect on the habitats and feeding-grounds of the wild life.

The Wild Life Department is doing a heroic job with an inadequate and underpaid staff. The Ranger of one large reserve that I know is not even provided with a jeep; he is expected to patrol an area of several hundred square miles on foot or bicycle. The poachers of course have cars. It is estimated that great numbers of the guns now in use on the Island are illegally possessed and must be assumed to belong to these same poachers, but according to the Ministry of Home Affairs steps are being taken to issue licenses to *all* applicants. It has also been decided to return those illegal firearms which were confiscated during the previous regime. The reason given for these decisions was that the people need these guns ' for protection in remote areas '.

No one would quarrel with the right of the villager to protect himself and his chena from attack by wild animals, and with this in view licenses for 1,11,357 guns were issued in 1955, certainly an adequate arsenal to cope with a few hundred elephants and bears. During the same period only 2,081 game licenses were purchased and the official kill of Axis deer was 80, sambar 5, and peafowl 10,—a minute fraction of the number of protected animals and birds destroyed either illegally or ostensibly in defence of crops.

The net of all this is that, unless there is strong public support for stricter protection, much of the Island's wild life will continue to diminish and some will become extinct. Now is the time for all sportsmen to help stem this tragic tide by banding together under the aegis of the Wild Life Protection Society and embarking on a plan of positive action.

The ducks were saved in America, and the wild life can be saved in Ceylon.

CHAPTERS ON THE HISTORY OF BOTANY IN INDIA

II. THE ADVANCES, AND IN PARTICULAR THE PLANT COLLECTING, OF THE THIRTIES AND FORTIES OF THE 19TH CENTURY

BY

I. H. Burkill

(*Continued from Vol.* 51, *p.* 878)

My first chapter carried the history of the science of botany in India as far as the time of Wallich's long leave, 1826-32, leave in which he took to London the collection of bundles of dried plants, that had grown up in the Calcutta Botanical Garden, and was allowed to draw from India House bundles that had been deposited there; all the specimens thus assembled he sorted, like to like, i.e., he assigned them to species, made them up into sets, and distributed these sets to, as he said, 20 centres of botanical work in 8 different countries, that they might do the great service of interesting the botanical world in the flora of India and of keeping botany in India in line with the advance of the science by ensuring the necessary international specific nomenclature.

This, the second chapter, carries the history forward a couple of decades. Although it covers a very much shorter time, it requires as many printed pages, and the names of the collectors are as many. That this should be the case indicates how greatly the two decades make a period of intensification. They make also a period of widening outlook and considerable achievement of reputations made or maintained and of strenuous undertakings. The beginning was in the nature of an awakening, for Wallich's leave extended long enough for Wight and Royle to require absence from India during it, whereby India was deprived entirely of its leaders in the Science.

Who were those left in India when the three were away? It will aid the reader to form an idea of the situation if they be enumerated. The seniormost was the missionary J. P. Rottler, whose knowledge of the flowering plants of southern India was considerable; he possessed a good reference herbarium and would name the specimens of others; but he was already 78 and losing his vigour. Bernhard Schmid, also a missionary, had moved from Tinnevelly to the Nilgiri Hills, where he was now at the beginning of his botanizings. Lieut.-Colonel W. H. Sykes, holding the post of Statistical Reporter, Bombay, was collecting plants in the Deccan; but he was not botanically minded and the collection went without determinations until entrusted to Royle about 1840. In Ceylon, James Macrea by a little collecting was adding to the herbarium at Peradeniya, but probably merely increasing the material without making determinations. The surgeon Alexander Gibson and the administrator J. S. Law were not out of their initial years in India and John Graham arrived in Bombay only in the year of Wallich's departure. On the other side of India, although the scientific membership of the Asiatic Society had strengthened, as the *Centenary Review* of the Society makes evident (p. 17), William Carey alone remained.

While conceding that the contemporaneous absences of Wallich, Wight and Royle created a situation, the pause of which made the years 1828-32 a dividing line, there was an associated circumstance not to be overlooked. It was that every botanist who resided in India, from Koenig to the years named, had been taught, thought and classified in the Sexual System of Linnaeus, a cramping, fettering system, bound to be superseded; and the first signs of supersession by the Natural System reached India after Wallich's departure on leave. The reader will now appreciate my use of the word 'awakening' as a character of the period under review.

It is rightly said that a system of classification demands knowledge of everything that is to be simplified by it. The objective justifies the system; and the Linnaean System simplified the arrangement of cabinets of specimens, lulled the born collector for whom it was prepared and was a means of getting on with what was immediately in hand, but raised a cloud of dust against the philosopher. Reynolds Green, writing in his *History of Botany in the United Kingdom* (p. 124; 1914) as a philosopher, condemns the Linnaean System more than it deserves. It was a product of its time, a ready help in assimilating in some order the flood of new species that emerged from the world-wide explorations of the latter part of the 18th century, a short cut or key. As meeting the situation it was a masterpiece. Not only did it do this, but by its simplicity it popularized Botany. The professors of the medical schools seized it, so to speak, with both hands and spread it out before their classes with the result that all the surgeons who came to India had a knowledge of it. Others joined the surgeons for, being so easy of comprehension, it took Botany to a place in a liberal education and even into the drawing rooms. India was affected by this diffusion in that the proportion of medical men who studied plants in India fell from two in three to one in three. Justifying my allusion to Botany in the drawing rooms, I would refer to the interest taken by three eminent ladies: the wife of the Marquis of Hastings, Governor-General from 1814 to 1825, would ask those who collected plants to give her duplicates that she might send them to a museum in Edinburgh in which she was interested; the wife of the Earl of Amherst, Governor-General from 1825 to 1829, was not only a keen gardener who sought out beautiful plants and got them into cultivation, but possessed a small herbarium; the wife of the Earl of Dalhousie, Commander-in-Chief, spent the warmer months of the year 1829 at Simla, where between Sabathu towards the plains and Mashobra deeper into the mountains she collected about 600 species. The Countess was competent enough to make determinations and very enthusiastic, as Carey who met her in Calcutta on the eve of her departure for Simla, has recorded for us.

The advances of Botany needed a little time before Europe was in a position to spread them to India. Fifty years passed from the publication by Linnaeus of his Sexual System to the publication by Antoine-Laurent de Jussieu of the Natural System, and rather over sixty from Linnaeus's publication to Koenig's bringing the use of it to India, Koenig and A. L. de Jussieu being contemporaries. The Natural System, devised and advocated in France, had to pass to and be taught in Britain, before it could follow to India; and the first teacher of it in Britain was William Jackson Hooker (afterwards Sir William), Professor of Botany at Glasgow, 1829-41; the second, John Lindley, Professor of Botany in University College, London, 1829-60. I shall have cause to mention both, not as visiting India but as exercising a considerable influence on those who botanized in India. Their influence began at the time of Wallich's long leave, or forty years after the publication of A. L. de Jussieu's *Genera plantarum* (1789).

I said (in chapter 1, p. 846) of my first period that no aspect of botany was studied except classification: the same is nearly true of the second period; but the classification had now a deeper insight.

A single illustration will bring home to my readers why it was so enormously to the benefit of the Science that the Linnaean System, having served for a short time, should pass away. Let us liken each system to a container of sufficient dimensions to hold all the units to be classified if accurately placed. The container by the Linnaean System would have directions for placing in its lower parts; that by the Natural System directions at all levels. It is obvious which of the two is the better. Could the theory of the origin of species have been arrived at by a Linnaean systematist? And is it not clear that the theory and the Linnaean System are incompatibles?

In the first chapter, heavy type was used to indicate the appearance in the narrative of the more important botanists: in this chapter it will be used more often as the history becomes more intricate.

William Carey and his Connections

William **Carey** (1761-1834) occupies a somewhat unique position in the history. He was a wonderful linguist. As the son of a village schoolmaster, he sought at first to find a way through life as a schoolmaster; then, in missionary fervour, he volunteered for a difficult life in India and landed in Calcutta in the year of the transfer of Roxburgh from Samalcottah to Calcutta, i.e., in 1783. To earn a living he became an indigo planter in Malda; and at that place he mastered the Bengali language into which he translated the New Testament. He had his translation ready when fortuitously a trained printer joined the Mission at Serampore, a printing press was obtained and Carey moved to the press. He had no aptitude for business, but was a born teacher and a perfect editor. He had become a friend of Roxburgh when still at Malda and acquainted with Colebrooke. After moving to Serampore he could easily reach Roxburgh's doorstep by boat; and the intimacy ended in Carey being Roxburgh's editor.

It has been stated (chapter 1, p. 870) that in 1813 Roxburgh, before he sailed from India for the last time, put into Carey's hands a manuscript copy of his *Flora Indica*. A delay in Ceylon gave him a chance of botanizing and he found a little information to insert in the copy which he sent by post to Carey. Though in the two years left to him before his death (1815) he continued to work on another copy of the Flora that he had taken with him, nothing more was added to the copy that he had entrusted to Carey. After his death Carey consulted Wallich regarding publication, and Wallich with characteristic impulsiveness volunteered to bring the MS. up to date by inserting his own finds. Carey agreed; and the first volume was issued in 1820. The second volume was delayed by Wallich's year in Nepal, but appeared in 1824. The third volume was never prepared because Wallich's affairs became too much involved. After Wallich had gone on leave in 1828, the Baptist Mission Press at Serampore holding the copyright, two of Roxburgh's sons approached Carey, asking him to print the whole work from the copy that their father had left with Carey; and this was done, save that for some undeclared reason the ferns were omitted; and the work appeared in three volumes in 1832. There is no sign of Carey in the text save for the editing; but Carey had become a botanist and was active. Prain in the preface to his *Bengal Plants* (p. 18) says that between Roxburgh and Carey 'little or nothing had been left . . . for successive generations of botanists to add' to the list of higher plants that occur in Central Bengal. Carey assuredly sent dried plants to Roxburgh which Roxburgh mixed with his own, but proof is lacking.

Carey almost immediately after he had domiciled himself at Serampore (1800) was appointed to teach Bengali in the Governor-General's new College in Fort William. This and a tremendous hunger for books drew him into Calcutta so much so as to make him equally a man of Calcutta as of Serampore. But except for a short paper on the agriculture of Dinajpur (*As. Res.* 10, p. 1; 1808) he published nothing in any way botanical. He cultivated a garden in Serampore assiduously. In the year 1820 he called together a meeting in Calcutta to originate an Agricultural and Horticultural Society. The meeting was badly attended, but getting official support he got his way, and the Agricultural and Horticultural (Agri-Horticultural) Society of India came into existence. It never operated far from Calcutta in spite of the word 'India' in its title. When Carey's move had been made, one of the two Tytlers who at that time showed an active interest in economic plants, R. Tytler, wrote that he had already ventilated in Allahabad the idea of a similar society; and we may take it that the time was ripe for Carey's move, though it expended its efforts in the introduction into gardens of plants suitable for them and very doubtfully touched agriculture at all. Wallich became its Secretary, or one of its secretaries, soon after its foundation and the Society was allowed the use of a part of the Botanic Garden as a nursery, of which it had the use until 1872. Wallich and his successors apparently saw no rivalry, though much of what the Society did was what they also were doing. Wallich wrote appreciatively of the Society's work in *Hooker's Journal of Botany* at a relatively late date (5, p. 137; 1853). The Society started *Transactions* of its own and provided an outlet for papers in economic botany.

Jacquemont on one of his visits to Carey's garden met there Professor and Mrs. **Mack** (he miswrote the name Mac). John Mack was a scholarly man from Edinburgh who had become a teacher in the College that the Mission had founded. He was not a botanist, but took an interest in some branches of Natural Science; and when in

1826 he and his wife visited the Khasia Hills on a tour of inspection, they made a collection of dried plants which they gave to Sir William Hooker. The excellence of the specimens received commendation.

To Serampore in 1827 a Danish surgeon, Joachim Otto **Voigt** (1795-1843) went to occupy the post which had been Wallich's 20 years earlier; and in Serampore he became a disciple of Carey. When Carey died he took charge of Carey's garden dedicated, as it was, to public service. He formed a herbarium which at his death was given to the University of Copenhagen and duplicates were given to Sir William Hooker which, therefore, are now at Kew. As will be mentioned later, Voigt had charge of the Calcutta Garden for two months in 1842 and the occasion gave him the opportunity of uniting catalogues of the Serampore and the Calcutta gardens into one under the title *Hortus Suburbanus Calcuttensis.* Voigt made more of it than a mere catalogue by embodying economic information, records of failures, experiences of himself and Carey at Serampore, and some information supplied by J. W. Masters, who had served as Head Gardener under Wallich (for Masters see pp. 61 & 64 forward).

Henry **Piddington** (1797-1858) was another who came under Carey's influence. After a few years at sea he settled in Calcutta and made a reputation as a meteorologist. But before he became absorbed in weather observations and after he had allowed himself to be elected a Secretary of the Agri-Horticultural Society, he prepared, manifestly at Carey's suggestion, his *English Index to the Plants of India,* which is a dictionary of vernacular names with botanical equivalents. Piddington calls himself a tyro in Botany; and this was his only publication that directly interests us. He remained for long active in the Agri-Horticultural Society.

THE UNOBTRUSIVE LEADERSHIP OF ROBERT WIGHT

Robert **Wight** (1796-1872) qualified in Medicine at Edinburgh when Daniel Rutherford was the professor. Rutherford fired no enthusiasms, and Wight did not leave the University a botanist. But when in 1819 he had entered the medical service of the East India Company and had found that the amusements of his associations in cantonments did not provide a congenial outlet for his energy, he turned, as he explained later in a letter to Professor von Martius, to the vegetable kingdom for occupation and in the leisure of his regimental duties studied the plants about him. He was soon sending collectors out to bring to him plants from distances beyond the limits of his own excursions. His station being Samalcottah (Samalkot), where successive official Madras botanists from Roxburgh forward had lived, the tradition of employing men of the country-side as plant-collectors was alive, and moreover it is not unlikely that he received help from Shuter. He managed to get three botanical works, an early edition of Linnaeus's *Genera plantarum,* Willdenow's *Species plantarum* and Persoon's *Synopsis,* by which he proceeded to determine his finds. These books kept him working by the Linnaean System which doubtless would not be strange to him. Perhaps it was well for this lone traveller that he had the easier artificial System to encourage him, though as will be seen, he was not slow in discarding it when his opportunity came.

Wight was transferred successively to Rajahmundry and Vellore. When he had been collecting for about four years, he needed help with his nomenclature, and made up a bundle of specimens which he addressed to Robert Graham, the new professor at his old University; but the bundle was lost at sea; and it seems as if Wight could not immediately make up another. However, he did so in 1826 and this packet he sent to Sir William Hooker, professor at Glasgow. By way of comment on the change, the reader may be reminded of Francis Hamilton's remark: 'Dr. Hooker at Glasgow I see frequently . . . he is more active than Graham.' Wight doubtless had chosen well and his material got attention. In the same year, Wight was taken from regimental duties and given the post of Botanist that had been successively Koenig's, Roxburgh's, Russell's, Heyne's and Shuter's. Koenig had travelled to Siam on it and the others to various destinations. Wight immediately travelled, going right to the very south of the Indian Peninsula on a zigzag course. Such journeys were of course costly because so much equipment had to be carried, food and a tent, employing a fair number of attendants, including an armed guard. Heyne, journeying from Samalcottah to Hyderabad, had a party of 40. Wight's much longer journey extended over 2½ months; it took him among other places to the Palni Hills where he found a flora quite new to him. But when in the next year he proposed a much longer journey, he was abruptly brought to earth by the abolishing of his post and by being sent to Negapatam, again in medical charge of a regiment.

Wight had been giving bundles of dried plants to other botanists, not all in Britain. Delessert in Geneva was one of the recipients.

After 2½ years at Negapatam, whence he collected as much as he could by sending out collectors, he took leave and brought all that he had to London in time to find Wallich in the middle of his work of distributing the Calcutta and India House material. The excellence of Wallich's arrangements so pleased Wight that he would have had what he had brought with him absorbed; and indeed Wallich had some of Wight's plants which he had obtained from India House to which Wight must have sent them. Wallich evidently could not take more; and Wight betook himself along with his newer collections to Scotland, where he found a co-adjutor in G. A. Walker Arnott.

George Arnott Walker **Arnott** (1799-1868) had been a school-fellow and also with Wight at the University; but while Wight was studying Medicine, he was studying Law. In the end he did not adopt the Law as his profession; instead, as Wight was becoming a botanist in India, he betook himself to Paris and studied Botany there. Returning from Paris, he worked with Sir William Hooker in Glasgow. Having met Bentham, he joined the last named in a tour of the Pyrenees. Could Walker Arnott, after study in Paris, after work with Sir William Hooker in Glasgow, and after a botanical exploration along with Bentham, have been a follower of the Linnaean System? That he was not; and he carried Wight into the Natural System, as they wrote conjointly their excellent *Prodromus Florae Peninsulae Indiae orientalis* on the material that Wight had brought back with him.

The first volume appeared in 1834, and then Wight's return to India arrested the work at a point which would have been one-third of the whole. The two collaborated in a couple of supplementary papers and that was the end of their association in work for India.

Wight, while engaged on the *Prodromus* was a welcome guest in Sir William Hooker's house; and Hooker happened to be engaged in preparing the plates for his supplement to Sowerby and Smith's *English Botany*. The idea of illustrating in a comprehensive way the flora of Britain, as that work did, gave rise in Wight to a desire to illustrate the flora of India in a similar manner, and out of that desire were born all these of his books: (i) *Illustrations of Indian Botany* with plates numbered 1 to 41, reproduced from Hooker's Botanical Miscellany, 1834, (ii) *Illustrations of Indian Botany* with plates numbered 1 to 182 in two volumes, 1840-50, (iii) *Icones plantarum Indiae orientalis* in six volumes, with plates numbered 1 to 2,100, 1835-'53, and (iv) *Spicilegium neilgherriense* in two volumes with plates numbered 1 to 202, 1846-51. To effect his purpose, he had to learn the art of lithography, which he did in Sir William Hooker's house, to train his artists, and to secure a printer. The printer worked in Madras city; Wight suffered from transfers to the Nilgiri Hills and then Coimbatore, as he told von Martius in a letter, at the inconvenient distance of 300 miles from his printer. He bore the expenses himself and the loss which, he says, was made tolerable by the Government taking 50 copies.

Wight on returning to India in 1833 was posted to Bellary; then his regiment was ordered to march to Palamcottah at the extreme south of the Peninsula. Wight found the transport of his impedimenta most inconvenient. After arriving at Palamcottah, he was sent on a mission of inspection to the experimental spice-garden at Kuttálam (Courtallam), a pretty place at the open end of a depression in the Ghats through which winds off the Indian Ocean carry coolness and humidity. Wight revelled in this place which gave him his second experience of the southern mountain flora; his first had been when he climbed the Palni Hills in 1826. But he contracted fever and was driven to take a period of leave which he used for a visit to Ceylon. He took with him two of his collectors and met there General G. W. Walker and his extremely energetic wife with whom he botanized.

At this point in my narrative it is desirable to record what had been the course of Botany in Ceylon after Koenig's visit in 1781 (see pp. 874-5 of the first chapter). I commence, therefore, with another missionary, Joham Peter **Rottler.** As Koenig was the first of the Tranquebar botanical missionaries, so Rottler was the last. Rottler (1749-'1836), after an education at the University of Strasburg, joined the Mission (1776) and lived in India for 60 years, for the first half working from Tranquebar and for the second from Madras city. He travelled and collected plants in many places and co-operated with others in making up sets of dried plants which had various destinations. One went to J. C. D. von Schreber at Erlangen and is believed to have been transferred later to Munich; another went to Delessert at Geneva; Wallich received two bundles on his return from his long leave; Wight was able to obtain a set; and in some way, earlier than

Wallich's leave, a set had reached India House which Wallich was allowed to have and distributed as 'Herb. Madras'. It is improbable that one set was like another; the Geneva specimens, for instance, are not to be assumed as of contemporaneous origin with what entered Wight's collections. Rottler at his death had a considerable herbarium which he bequeathed to the Vepery Mission and the Mission sent it to King's College, London; this collection, the college gave to Kew in 1872; but there is a suspicion that it had ceased to be entire. Rottler's specimens were commonly devoid of any locality of collecting.

Rottler made two visits to Ceylon, one in 1788, the other in 1795. The conditions in 1795 were very favourable for collecting, as he had been engaged to travel with Hugh Cleghorn (1781-1834), Private Secretary to the Governor of the island and after that the first Colonial Secretary, that he might serve as interpreter in a tour of inspection. The tour over, he remained to continue the collecting. By arrangement, specimens were sent to India House in 1797. Rottler's biographer, Thomas Foulkes, states that he was informed by Cleghorn's grandson that they were subsequently put into the collection at King's College. Rottler's mastery of Tamil led to the preparation of a dictionary. Of its three volumes only one was printed before Rottler's death; the other two were issued in 1837 and 1839. In the dictionary are to be found the first equatings of botanical and Tamil plant-names. Five years after the third part had been issued, the Tamil botanical dictionary of Simon Casie Chitty came out as a further effort at passing the terminology of Botany into southern India.

But to return to Ceylon, after Rottler the next to botanize in Ceylon was William **Kerr,** chosen by Sir Joseph Banks in 1812 for the management of the Garden in Colombo where he died in 1815, to be succeeded by Alexander **Moon,** likewise chosen by Sir Joseph Banks. Moon moved the government garden to Peradeniya, where he died in 1825. His successor was James **Macrae,** chosen by Lindley; he served from 1827 to 1830. Kerr, Moon and Macrae had graduated for appointment by travel in search of plants for cultivation; and the establishing of such in Ceylon was their first duty. Moon was the best equipped for the work and published in 1824 *A Catalogue of Ceylon Plants* which holds the names of 366 species that he had alive in the Peradeniya Garden, together with the names of plants found outside that he recognized, bringing the total to 1127. Moon made no acknowledgement of help from Europe, but there are specimens in the herbaria of London indicative of correspondence. Macrae sent specimens to Lindley and added also to the collection of dried plants which Moon had started; but Macrae's time in Ceylon was very short. After Macrae's death Peradeniya had in turn 5 care-taker superintendents; one of these was J. G. **Watson,** accepted on the recommendation of Wallich when on leave in London; another was J. G. **Lear,** an employee of the horticultural firm of Knight of Chelsea, who being in Ceylon was locally taken into employment. During Watson's service, the traveller Baron Karl **von Huegel** spent four months in Ceylon. Contact with Watson is not recorded and of the visit little is in print except that he collected and dried plants extensively, as recorded in a privately printed memoir of 1904 wherein the places that he visited are named; and Bentham visiting Vienna in 1839 saw there the Baron's collections.

Almost throughout the years of these care-taker superintendents General G. W. Walker was in Ceylon; and the General was virtually *in loco parentis* to the Garden.

George Warren **Walker** (——1844) had been Governor of St. Helena and from that island he and his wife had been active in sending plants and seeds to the Glasgow and Edinburgh professors, i.e., to Sir William Hooker and Robert Graham. After a subsequent period of leave, the General was sent in 1830 to Ceylon as adjutant-General, where in unhurried journeys of inspection through all parts of the island, the palanquin bearers who carried him would command his interest by drawing attention to flowers seen by the way, and these the General collected. Wight having gone to Ceylon, as recorded, went on one of these journeys with the General. It is obvious that Mrs. Walker would travel less than her husband; but she ascended Adam's Peak on one occasion and wrote a long account of her experiences which Sir William Hooker printed (*Compan. Bot. Mag.* 1, p. 3; 1835). She did most of the correspondence regarding their plants, but he the business of despatching etc. They looked to Hooker and to Graham for determinations, and sent much to them, enriching at the same time the herbarium at Peradeniya. The General expressed his complete disapproval of J. G. Watson as merely a collector and entirely unable to read the Language of Botany; and he begged that a scientific man should be placed in charge of Peradeniya. Watson certainly collected; and the fact that he obliged Wallich with dried garden plants when Wallich asked for them may be kept in mind in connection with Wallich's selection of him. He sent dried plants also to Lindley. It is not unlikely that the General's protests reached quarters influential enough to secure the appointment of George **Gardner**, the first botanist as distinct from horticulturist to be in charge of Peradeniya.

Wight's visit to Ceylon in 1836 and contact with the General led to an undertaking on Wight's part to name up the Peradeniya collections; and these were entrusted to him for the purpose. Wight then proceeded to supplement the Ceylon material, placing again in Ceylon in 1837 two collectors. If, as seems to have been the case, the whole of the Peradeniya herbarium was packed and sent to Wight, its size at the time would not have been great.

In 1838 another botanist of the Army arrived in Ceylon; this was John George **Champion** (1815-45). He was stationed at first in the centre of the island and later at Galle. He did not meet Wight but they corresponded. Champion was at Galle when Prince Waldemar of Prussia, making a tour of the East, landed at the port of Kalutara which is between Galle and Colombo, bringing with him as his personal physician the young and inexperienced botanist Werner **Hoffmeister.** Champion took the physician botanizing, while the Prince proceeded to Kandy and was shown round the Garden at Peradeniya by the artist Harmanis De Alwis. At this date General Walker was no longer in the island. Threats of war in the north of India had caused his transfer to Madras in 1837, then to Calcutta, then to Meerut; finally, after a visit to Mussoorie, he and his wife ended at Simla. In 1844, Champion, who had taken the unofficial position towards Peradeniya that had been the General's, corresponded with Wight regarding the loaned collection, and saw that it was back in place for the use of Gardner. Wight evidently had had it for a long time.

Before Gardner's arrival another botanist had reached the island; this was William **Ferguson** (1820-87), a professional surveyor. Gradually he developed a special interest in economic plants, in ferns, and in seaweeds. However, his years of activity really belong to the third period of this history.

George **Gardner** (1812-49) had been a pupil of Sir William Hooker and, when qualified in Medicine, had travelled for 5 years in Brazil. It is interesting that to have travelled seems to have remained a qualification for the Ceylon appointment. It is doubly interesting that an occupant should have been chosen with a botanical qualification. Unfortunately the seeds of ill-health were in him and almost immediately he was obliged to take leave; this he did by returning Wight's visit; he went to the Nilgiri Hills and botanized there with Wight. In 1846, Wight had joined the editorial staff of McClelland's *Calcutta Journal of Natural History,* and now Gardner was added. Griffith had become an editor two years earlier. Gardner now used the opportunity it afforded him of publishing. An editorial staff including Griffith, Gardner and Wight was a strong one botanically; but the financial support which the journal obtained was inadequate. The Asiatic Society of Bengal a few years earlier, manœuvring to finance its output of print by offering for sale separately the scientific and literary papers that it accepted for the *Asiatic Researches,* had observed that it was left with unsold scientific parts when the corresponding literary parts of volumes were sold. This demonstration regarding demand might have pointed to difficulties that McClelland's venture had to face.

Wight's short period on the staff of the journal was almost his only connection with northern India, except correspondence with Wallich and Griffith, so completely did he belong to the Peninsula where his authority in taxonomy extended from Ceylon to Bombay and from Ceylon to the Circars. It was indicated in my first chapter (p. 873) how John Graham accepted that authority; it will be indicated how it was passed on through Gibson and Dalzell; Nimmo's friendship with Wight was built on it; and from what has just been recorded, it is clear how it was established in Ceylon.

Immediately before the illness which led to Wight's holiday in Ceylon, he had had information that his employment was to be changed. He told Walker Arnott that he anticipated a roving life and that it might be for a year or longer. It proved not to be a roving life and it lasted 17 years. He was removed from the Military Department and told to enquire into the state of Agriculture in southern India and to conduct experimental cultivation of cotton, tobacco, senna, sugar, coffee, spices, and madder and to enquire into the possibilities of cinchona. Cotton was put into the front. For a time he resided in Madras city where he undertook the management of a garden started by a new Agri-Horticultural Society and was drawn into the affairs of the Madras Society of Literature and Science, contributing several papers to their Journal, always such as had an interest beyond his own subject of taxonomic botany. From Madras city he was moved to the Nilgiri Hills and then to Coimbatore. Ten bullock carts were required to move his collections and machinery from the one to the other. Without doubt, he collected much in the Nilgiri Hills; at Coimbatore he was but a short distance from the Anamallai Hills; but C. E. C. Fisher does not find that he collected in them (see *Records Bot. Survey Ind.* 9, p. 5). In 1853, his retirement came. The collections which he then brought to London for final elaboration were in a very large measure made up of southern hill-plants got by his collectors. These plants were distributed from Kew in 1869.

Wight left India too soon to have any part in the establishment of Cinchona. The first individual plant to reach the East was in Java in 1851 and further plants in 1854; it was not until 1860 that planting commenced in the Nilgiri Hills and the establishment there was the work of William Graham McIvor, Superintendent of a Botanic Garden established at Ootacamund.

FURTHER COLLECTING IN SOUTHERN INDIA

When in 1828 Wallich brought together all the collections that he could command, he had a small number of species from the Nilgiri Hills collected by Leschenault and a larger number collected by P. J. Noton of the Bombay Mint. In 1827, an association called 'Unio Itineraria' i.e., the Travel Union, was formed in Germany at Esslingen near Stuttgart, with the object of maintaining a collector or collectors of plants in the field whose collections were to be divided among the subscribers. Under the guidance of Ernst Gottlieb Steudel and Christian Friedrich Hochstetter, the Union prospered; they handed it over as a going concern in 1842 to the charge of Rudolp Friedrich **Hohenacker**, to whom it occurred that there might be a market for dried plants from that part of India where Rheede's *Hortus Malabaricus* had been illustrated. Hohenacker sought for but failed to get someone to collect actually in Rheede's country, i.e., near Cochin, but found a missionary, F. **Metz**, resident at Mangalore, 240 miles further north, prepared to do the collecting. Hohenacker could scarcely have been expected to know that Mangalore is outside the climate of Cochin: it is beyond where the second annual peak of rainfall which characterizes the Equator has died away and is where the months of April and May have a dryness that influences the vegetation. F. Metz of the Basle Mission was not a botanist, but a collector ready to earn as much as he could, that he might put up mission buildings. Hohenacker sought for someone in Britain to name the plants when they had been collected, but in vain; and he accepted the services of Frederik Anton Willem Miquel who was at the very beginning of his career. Miquel naturally was slow. The first dividend came at the end of 1847. The plants distributed then are labelled Kanara and may be assumed to have come from within the District of South Kanara. Next, Metz had a short period of collecting about Mercara in Coorg; he was now at an elevation probably not reached at all by men who brought Rheede's plants together. Then the Mission moved Metz to the village of Keti at a few miles from Ootacamund in the Nilgiri Hills and holding still less of Rheede's vegetation than at Mercara.

However, he had not done much collecting before he decided to cease in consequence of heavy losses between gathering and shipment. He had been a diligent agent whose specimens, indifferent at first, improved as he gained in experience. Some authors quote these specimens as Hohenacker's, which is misleading, for Hohenacker was only an intermediary.

Another missionary was living in Ootacamund when Metz was moved to Keti whose interest in the plants of the Nilgiri Hills was deeper. This was Bernhard **Schmid** (1787-1857). His first place of residence in India was in the District of Tinnevelly. There his health broke down, driving him to the Nilgiri Hills, where, it seems, his botanical interests were aroused. Not wholly recovering, he returned to Europe, taking with him or having to follow him a small collection of dried plants and some coloured drawings. He had been trying to determine what to call his plants by the use of Roxburgh's *Coromandel Plants* and Persoon's *Synopsis,* neither work likely to be really helpful. At the end of the year 1831, Baron Karl **von Huegel,** who has been mentioned already, had reached Bombay, and from Bombay, he worked his way southwards, reaching the Nilgiri Hills in February and botanizing there with Schmid for six weeks. Karl Alexander Anselm von Huegel (1795-1870) was of German ancestry, but Austrian adoption—a great collector who enriched the Vienna Museum considerably by what he brought to it. He records that Schmid conducted him about the country-side and put his herbarium freely at his disposal. Doubtless, specimens still exist which Schmid put into von Huegel's hands. Schmid had a list of 471 species which he recognised and might name to the genus and only rarely to the species. In 1836, he returned to Europe and being a native of Weimar which is only 20 miles from the University town of Jena, it was natural that he should make contact with Jonathan Karl **Zenker,** the professor of Botany in that University. The date and manner of making contact is not known; but the result was that Schmid gave to Zenker the materials from which Zenker published in 1845 a decade of *Plantae indicae quas collegit Bernardus Schmid,* followed by a second decade in 1847. Zenker died in 1848, and there were no more decades. The botany of the two published was entirely Zenker's; and Zenker had had to build on to the original drawing by dissections and perhaps sundry details. Zenker has been accused of disregarding the work of others assuming novelty for whatever he had.

At the time of von Huegel's visit to the Nilgiri Hills, a resident medical officer was preparing a guide-book, his name R. Baikie. Von Huegel helped him by supplying notes on the climate and vegetation, posting them back to Dr. Baikie from Ceylon, to which he proceeded after leaving the Nilgiri Hills. These notes were incorporated by Dr. Baikie in the text of the book *Observations on the Neilgherries* (1834); Schmid provided his list of 471 species and Baikie appended it together, with three coloured plant-portraits. If the three portraits represent, as is probable, the foundation that Zenker had for his plates, a good deal of each of Zenker's plates was due to Zenker. Schmid returned to Ootacamund in 1845 and remained there for the rest of his life. Before returning he visited London and called on Sir William Hooker at Kew. This visit resulted in a promise to give dried plants to Sir William, who provided the drying paper; and it is recorded in the *Kew Bulletin* (1901, p. 52) that Schmid sent nearly 1,000 during the next few years. He sent lesser numbers elsewhither: Urban records (*Jahrb. Bot. Berlin,* 1, p. 61; 1882, mis-spelling Schmid's name) the receipt in 1848 of 41 specimens; and it is recorded by Thomas Thomson that the Calcutta Garden received a bundle. In 1857 Schmid, aware that his life was near its end, asked Sir William Hooker what he should do with specimens still in his possession and was advised to offer them to Hohenacker. If Hohenacker received them, they were added to Metz's plants. It is apparent that the greater part of the flowering plants which Schmid collected are now in the Kew herbarium. Schmid had been collecting ferns and mosses. Just before his death he received a list of determinations of ferns that he had sent to Gustav **Kunze,** the Professor at Leipzig, and forwarded it to the Madras Society of Literature and Science. It was printed in their Journal (19, p. 79: 1858). His family received soon afterwards a list of mosses determined by Johann Karl August **Mueller** of Halle; and this list appeared in the same volume (p. 84).

In the year of Schmid's death a second edition of Baikie's guide book appeared, edited and much altered by W. H. Smoult, but Schmid's list was unaltered. Smoult was a man of Calcutta, interested in economic plants.

The following were collectors of plants in the Nilgiri Hills of Schmid's time:—Sir Frederick **Adam,** Governor of Madras from 1832 to 1837; two missionaries, Thomas **Foulkes** and another named **Weigle;** and the energetic 'botaniste-agriculteur' George Samuel **Perrottet** of Pondicherry. The first two sent their collections to Sir William Hooker; the third collected the mosses that reached J. K. A. Mueller; and the collections of the last were on sale in sets in 1853 and 1857. Perrottet's were by no means all from the Nilgiri Hills; he collected widely, even up to Bombay.

Metz's collecting in Coorg has been mentioned. He was not the very first to interest himself in the flora of Coorg, for in 1811 a surgeon named David **White** published an account of the Cardamom cultivated along the Ghats (*Trans. Linn. Soc.* 10, p. 228). Rottler in some way obtained plants from Coorg. In 1834, the State was extensively explored by Captains William **Munro** and George Stevens **Gough** who made rather large collections. William Munro (1818-80), ultimately a General, began his collecting in India in Coorg and continued it in many other parts of India until 1848, when he took considerable collections to London to work up with the help of Bentham. Previously, he had given specimens liberally to Wight and Griffith. George Stevens Gough, later the second Marquis Gough, appears to have done more collecting than what he did with Munro in Coorg and in the Nilgiri Hills. There are other collectors of south-western India who need naming. One was Charles **Mitlett,** a tea-merchant who yearly spent the tea exporting season in Canton, but between the seasons was able to travel back to Ceylon or Malabar: little is recorded of what he collected in these places, but of what he collected in China much (see Bretschneider, Hist. European Bot.

Discoveries in China, p. 288; 1898). Another was Thomas **Lobb**, an employee of the horticultural firm of Veitch: he in 1848 collected showy plants on the western side of the Ghats and in Mysore. A third was the Rev. E. **Johnson**, who resided in Travancore and contributed a list of orchids, which he had found, to the *Madras Journal of Literature and Science* (19, p. 215; 1858).

In Ceylon a great interest in the ferns arose, and three men became specialists in these plants. One was Sir William **Norris** (1793-1859) who had been in Ceylon as Puisne judge, then Recorder of Penang, and lastly in Ceylon again as Chief Justice. He did not confine his collecting to ferns; but they were his greatest interest, and he sent his difficulties to Sir William Hooker for determination. The other two were in business in Colombo, George **Wall** (? 1821-94) and Thomas W. Naylor **Beckett.** They became friends of Thwaites when he succeeded Gardner as Superintendent of the Peradeniya Garden, and worked conjointly at the ferns with him. The collection of Beckett is at Liverpool.

The zoologist Thomas Caverhill **Jerdon** (1811-72) collected plants in many parts of southern India and retained his collections until his death, after which they were given to Kew.

John **Campbell,** an army officer, brother of William Campbell, who was the first secretary of the Edinburgh Botanical Society, collected during the years 1835-37 about Hyderabad and in the Circars, and sent plants to Wight.

'THE ASSAM DELEGATION' TO ENQUIRE INTO THE POSSIBILITY OF A TEA-INDUSTRY IN NORTH-EASTERN INDIA

For a century before the foundation of the Calcutta Botanical Garden, merchants had known that it was possible to obtain seed of the tea bush and grow the plant, but that the production of commercial tea did not follow. And so it was that the bush was brought into the Garden soon after its foundation as something of interest and then introduced afresh by Lord Macartney's Embassy to China in the year of Kyd's death (1793), certainly then with an emphasis on possibilities. According to **Wallich,** whose knowledge of the Garden was not contemporary with either of its introductions but began in 1807, the bush as he knew it from that date to 1828 was always sickly; but did not die. Merchants in India perhaps took no interest whatever in its presence in the Garden; but they could not forget what large profits would follow successful production of commercial tea in India. Govan, when superintending the Saharanpur Botanical Garden, advocated trying tea there. But India got no further. It was in London that a movement was started; a Mr. Walker, a member of the East India Company, moved the Company to action; he had read in the library of the Company at India House Francis Buchanan's account of the raising of crops in the Shan Hills and of trade in the leaves to the Burmese; and he had found in a copy of Don's *Prodromus Florae Nepalensis* that Edward Gardner, when Resident in Nepal in 1820, had found there a bush in cultivation and had sent a twig to Wallich in Calcutta (see Communications Relative to the

Cultivation of the Tea Plant in India, (1839). As Wallich was in London when Mr. Walker moved the Company, he was asked to comment; and along with informing the Company that the bush was unhealthy in Calcutta (he did not diagnose the cause), he suggested that suitable situations might be found in the mountains of India, perhaps in Kumaon, Sirmur or Garhwal, 'corresponding entirely with those in China and Japan in which the cultivation of the tea shrub is carried to the greatest extent and perfection'. The Directors put the papers, including Wallich's memorandum, into the hands of Lord William Bentinck, who had just been chosen to be the new Governor-General; and he on his arrival in Calcutta in 1833 laid them before his Council with a recommendation for attention. Wallich by this time was back in India and became inevitably one of the members of the 'Tea Committee' which was nominated by the Council to formulate proposals for action. The Secretary of the Committee was a merchant, G. J. **Gordon.** The mercantile community was further and well represented. One of the official members was James William **Grant** (1788-1865), a man of wide interests whom I shall need to name again. He was the Grant to whom Griffith dedicated his genus *Grantia;* and he was for a short time, two years after nomination to the Tea Committee, in temporary charge of the Calcutta Botanical Garden. The Tea Committee first of all sought advice at Saharanpur from Hugh **Falconer** who had succeeded Royle; and Falconer advised exactly as Royle would have done that trials should be made in the near-by Himalaya, 'from Dehra Dun up to 3,000 ft.'. Wallich concurring pointed out the presence there of his seed collector, Robert **Blinkworth,** who could be made available to assist. So he was; and it seems that he was involved in planting in Kumaon or Garhwal to the end of his life. As a second recommendation the Tea Committee asked that seed be procured from China; and it was decided that Gordon should go to get it. Wallich thereupon volunteered to act as secretary and was appointed to do so, being thus brought to the very centre of the Committee's business. He offered to go to the north-western Himalaya, where he would have made extensive plans for the receipt of what Gordon was to get; but the Government decided that this was not necessary. Plans were made for the distribution of the seed to come from China and most of it was to go to the north-western Himalaya; the Nilgiri Hills were to receive a fair quantity and the balance was assigned to unspecified places in southern India. What arguments were adduced to give second preference to the Nilgiri Hills cannot be stated. Assam was not thought of; then suddenly it came into view, by the discovery that a rumour of several years earlier that tea actually occurred there was founded on fact. The story of the discovery is complicated by the number of men who had a part in it.

In 1823, a certain Robert **Bruce** travelling up the Brahmaputra, as others were doing, on the look out for a business opening, was successful in getting into relations with a Singpho chief; and from the Singphos he learned that they prepared for themselves a tea locally. As he told no one, his position remains somewhat shadowy. In 1824, the first Burmese War broke out. Many an officer during the fighting and exploring would have had a chance of learning as much as Robert Bruce had learned; and it would seem that it was then that the rumour referred to above reached Calcutta. But the only record of this rumour is in a much later circular of the Tea Committee. The Governor-General's agent on the North-eastern Frontier in 1826 was a capable officer by name David **Scott**; and into his possession came a leafy twig from Manipur, said to be of a shrub which gave tea. This he sent to Calcutta. A statement that it came from Tezpur was an error. Wallich with caution decided that the specimen probably represented a species of the genus that gives tea, but not the tea bush itself; and he put it away as *Camellia* (?) *scottiana.* Scott died without doing more. Pemberton afterwards told Griffith that this plant was only known from one spot, which may well have been true as to the knowledge; but according to Sir George Watt, who explored in Manipur in 1883, there is much wild tea in eastern Manipur.

When the Burmese War broke out, a younger brother of Robert Bruce, **Charles Alexander Bruce**, arriving in India as part of the personnel on one of the Company's ships, volunteered for war service and was given charge of a gun-boat or gun-boats on the Brahmaputra; and he remained in Assam after the war, policing the upper waters of the river. In 1831, he passed under the orders of a new political officer, Captain **Charlton.** The two from this date took parts in the exposure of Tea in Assam that can scarcely be distinguished. While it is evident that Bruce had opportunities of knowing more than Charlton by reason of longer residence, Charlton had the administration in his hands, and whatever knowledge there was to be passed on passed through him to the Governor-General's Agent at Gauhati. This was Francis **Jenkins** who had succeeded David Scott in the position. According to C. A. Bruce, the Singphos reminded him of his brother's interest in the Tea. Robert had died. Records show that Charlton had a knowledge of the presence of Tea at least in 1832, for in that year he wrote to Jenkins regarding it and, more than that, he tried to send a living plant to the Calcutta Garden. Wallich presumedly had not yet returned, and Charlton tried to get it to its destination by the services of the surgeon, John Tytler, but he failed.

Charlton brought seedlings into his garden; but this may not have been until 1834. The Singpho village of Bisa in the Lakhimpur Frontier Tracts near the Burhi Dihing river is likely to have been the place whence they came, for Bruce appears to have been familiar with the growing there. It is 30 miles in a straight line from Sadiya. Charlton who had submitted specimens to Jenkins in 1832, submitted more in 1834. Dr. H. H. Mann suggests (in 'Bengal : Past and Present,' 72, p. 11) that Jenkins had asked for them which is extremely probable, for it is certain that neither Charlton nor Bruce had clear ideas of the importance of the presence in Assam of the Tea bush.

Charlton sent leaves to Jenkins in May and leaves with fruit in November. These Jenkins forwarded to Wallich who determined them as representing *Camellia theifera,* the true source of Tea. He immediately informed the Tea Committee (24 December 1834), and the Committee recommended that a Delegation be sent to study the conditions under which Assam produced it, Wallich to be in charge with another botanist and a soil expert to support him, the botanist to be

William **Griffith** and the soil-expert John **McClelland**. Jenkins expected that the area of the Tea bush in Assam would be found to be the margin of the tea-growing area in China and had ideas of using the occasion for ascertaining the nature of the country of northern Burma and towards Yunnan.

William Griffith (1810-46) was mentioned in my first chapter (p. 876) as having been brought to Wallich in London by his teacher Lindley, and as having drawn up accounts and made illustrations which Wallich put into his *Plantae Asiaticae Rariores*. Wallich was so impressed by Griffith's ability that, on learning that he was about to sail for India, he made up for him a small bundle of named plants to help him to recognise species which he was sure to meet. Griffith then reached Madras already with a reputation. From Madras he was sent to Mergui and he was in that distant post when wanted by the Tea Committee.

John McClelland (1805-85) had joined the medical service in India in 1830 and was in Kumaon, when he likewise was wanted. His interest was in Geology; but at times in his career he turned botanist and collected rather considerably; in 1849 he did this in the Bengal district of Birbhum and in 1855 in Lower Burma. The two young men, Griffith 24 and McClelland 29, were ill-matched with Wallich, who at 48 was old for his years.

Francis Jenkins (1793-1855, ultimately a Major-General), after proving his ability as an administrator at Nagpur, succeeded to the post of Agent to the Governor-General at Gauhati in Assam. He would have the Delegation cross the Khasia Hills and he would send them from Gauhati up-stream; but that was not all; he sought to arrange that a party would come to the Assam border from the Residency at the Burmese Court to meet at the frontier a party that he would send from Assam. As it required a little time to get Griffith to Calcutta, Jenkins had time for planning. Finally Wallich, Griffith and McClelland left Hugli by boat on 31 August 1835, to thread the Gangetic delta and then the jheels of Sylhet to Terrya Ghat, whence they climbed to the plateau, Griffith both in the jheels and on the plateau meeting a vegetation the like of which he had not seen before and collecting with that intensity which was his, Wallich to whom the plants were not altogether new relatively indifferent. Disastrously, Wallich had not brought enough drying paper, and a quarrel resulted when Wallich deprived Griffith of his means of collecting. McClelland seems to have silently sided with Griffith, as he saw Wallich removing Griffith's specimens from the plant-presses to make room for his own. Wallich afterwards could write generously of Griffith (see for instance in Hook. Journ. Bot. 1841, p. 192); but Griffith never forgave Wallich, though in his private diary he wrote at the time the excuse for Wallich that he was ill, and when ill was irritable. Griffith had already planned his own 'Flora Indica'; and this could have irritated Wallich, for Wallich would not forget his own failure to produce an extended edition of Roxburgh's *Flora Indica*.

During the assembling of the Delegation, Gordon returned from Canton with the first of the several consignments of Tea seed that he was destined to procure. The missionary G. Gutzlaff had helped him and was in a good position to do so for he served the Chinese

Inspector of Trade as an interpreter. Of this first consignment of seed, 20,000 were set aside for Assam and 20,000 for the north-western Himalaya; the balance, which was small, was allotted to the Nilgiri Hills. An attempt to forward the consignment in a germinated condition was made, possibly with injudicious haste, and the seed for Assam arrived the worse for that at their destination, Sadiya, early in 1836. The Delegation must have been in the Khasia Hills when the seedlings left Calcutta; its three members arrived at Gauhati on 23 November 1835, and left for Sadiya nine days later, reaching Sadiya 16 January 1836, just ahead of the seedlings. Before that date, Charlton had had the misfortune of being wounded in repelling a raid into the valley, and he was in hospital, Bruce being in charge of affairs. Charlton's garden with the transplanted tea plants in it was a mass of weeds and its fence broken through by straying cattle; however, the young plants were there for the Delegation to see. Bruce took the Delegation forthwith to Bisa, where two areas were examined. On the way back to Sadiya another, 12 miles above Sadiya, was visited. Next, a site for a nursery for the seedlings from China was selected, the position being Saikhoa (alias Chykwa) within a few miles of Sadiya. Bruce then took the Delegation to the Muttack country on the east side of where Dibrugarh now is; and for more than a month they wandered very uncomfortably from one area where the Tea bush was to another. Lastly they went down stream and visited an area in the neighbourhood of Jorhat. McClelland, whose report on the soil seems to have been excellent, thus got the facts on which to form his judgment. Griffith thought that Bruce's knowledge was superficial and in this doubtless was right; Bruce grew knowledgeable later. As soon as the Jorhat area had been seen, Wallich, extremely anxious to get away from what he thought would end his life, went down stream, taking Bruce with him, the others of the Delegation thinking that Wallich had left them behind with the intention of excluding them from a hearing. They made a short expedition into the Naga Hills; and then Griffith passed under the direct orders of Jenkins.

When Bruce had cause in 1839 to report to the Tea Committee on subsequent work, he gave a map showing in how many further areas he had found the Tea bush.

By Jenkins's arrangements Griffith was to join the exploring party for the Burmese boundary in the next cold weather; meanwhile he was established at Sadiya, and stayed there except for an attempt made with Jenkins's approval to penetrate the Mishmi Hills along the beginning of the route which Wilcox had used when in 1827 he succeeded in establishing the volume of the Irawadi at Manchi and therefrom the not altogether remote position of its origin. Griffith, however, was very soon turned back by want of porterage, but not without considerable collections. Immobilized in Sadiya by the rains, he threw his energy into detailed examinations of the plants about him, carrying his investigations as far as his microscope could take him in accordance with a habit that he had formed either at, or more probably before, coming to India and now, with the lure of his 'Flora Indica' ahead, intensified. At Mergui, his regimental duties had been light enough to have allowed him to commence collecting these descriptions; at Sadiya he had nothing to prevent him from getting on with them until in February 1837 came the time for joining the party for the Burmese frontier. It was led by Major A. White. Griffith, before he started, examined the nursery of Tea seedlings at Saikhoa and found the last of them perishing. Major White's party ran into great difficulties; for that reason it could not keep together but trailed out; and the forward part got to the top of the Patkoi Range with the hinder part unable to catch up. Griffith was in front when a messenger arrived to say that the party from Burma was not far away. This party was led by Dr. George Thomas Bayford and had been two months on the way. It was to be another two months in getting back. There was a meeting between it and the front of Major White's party on 5 March 1837; but the transport had got into such a state that both parties had to go back, and Griffith's extremely forward position made it expedient that he should join the Burmese party rather than go back as Major White did; he and Bayford therefore went to Ava. It was a wonderful journey: the track was not unknown, but was through lawless country and uncivilized stock, by habit resentful of strangers, though perhaps opportunely rather cowed by the tramp of armed men through the hills during the fighting of the Burmese war. Passage had to be bought, Griffith says, expensively. A remark by McClelland in an obituary notice that 'Griffith travelled with only one servant' has been misinterpreted into 'travelled with only one companion'. It was not so; but he travelled in a very small party and must have foregone largely the making of collections. Yet he collected even in the Hukawng Valley which he crossed, then reached the limits of Chinese seeking amber and jade, and so Mogaung, from which place transport by water was available. Griffith got the Tea bush once; and Captain S. F. Hannay, a member of the Assam party, when he had been in Burma earlier had seen it once, so that the journey seemed to confirm Jenkins's idea of continuity between Shan tea growing and Singpho encouragement, the Singphos finding it worth while to fell rival shrubs to increase their limited supplies—the occurrence natural, the local abundance consequently artificial.

From Mogaung to Ava, Griffith and Bayford used water-transport and reached the end of their adventure in May.

Griffith's diary, reproduced as pp. 60-108 of the appropriate volume of his *Posthumous Papers,* gives in detail what he saw on his journey and pp. 115-145 give a report which he made to the Government.

Griffith must have remained for several months in the neighbourhood of Ava; then he descended the Irawadi to Rangoon, taking along with him considerable collections. He contrived to reach Calcutta by sea in May 1838. After the manner in which Wallich had left him at Jorhat, breaking up the Delegation, he had not expected to be required to make a report on Tea, but he was asked to do so. Complaining that the facts were no longer fresh in his memory and that the collections of the Delegation, which had been for two years at Calcutta in Wallich's possession for study, had not yet been got into such order that he could profit by them, he obeyed the demand and reported to Wallich who sent the report to the Agri-Horticultural Society for publication (*Trans.* 5, pp.—85). In it, Griffith, on data much too meagre, sought to argue that the genera associated with the Tea bush in Assam, by occurring also in the tea tracts of China, showed the bush endemic in both places. He was disappointed that Wallich had not cleared the ground for him.

Griffith's connection with Tea ceased with the report. On the other hand, C. A. Bruce had become wholly absorbed; his activities may be judged by a pamphlet printed in 1838, entitled *An account of the manufacture of Black Tea as now practised in Saddiya* and by a report which he sent in 1839 to the Tea Committee which distributed it, and the Asiatic Society of Bengal printed it (Journal, 8, p. 1297), as also the Madras Society of Literature and Science (Journal, 10, p. 169). The number of patches or plantations under his charge becoming too numerous, they were divided into two groups, half under him and half under John White **Masters** who had been Head Gardener in the Calcutta Garden under Wallich. Next, the Assam Company having been established, the Government made over the larger part of the patches to its care, glad to be freed from what was under them a costly undertaking. The Company retained Bruce and Masters until 1843 and then tried new controls. Masters went back into the service of the Government and became sub-assistant under Jenkins in the Nowgong District in which position he made an expedition into the Naga Hills and on it collected plants which were sent to Calcutta. Later he was Extra Assistant Commissioner of Golaghat and when he retired in 1862 was awarded a special pension for 'his very high character as a public officer'.

Jenkins caused large collections of dried plants to be made about Gauhati. Under him at that place as the Government Apothecary was Charles J. **Simons** who collected both in the valley and in the Khasia and the Mikir Hills. The earlier of these collections were sent to the Calcutta Garden, the last to Sir Joseph Hooker. Jenkins obviously helped Thomas J. **Booth** to make his horticultural expedition from Bishnath into the hills of the Daphlas at the south-eastern corner of Bhutan. Booth had been sent to India by his uncle Thomas Nuttall, the eminent American botanist.

GRIFFITH'S FURTHER SERVICE

Griffith was not allowed to stay long in Calcutta after his return from Burma, but was detailed to accompany the Mission of Captain Robert Charles Boileau Pemberton to Bhutan. Again he left Hugli by water on the last day of the month of August; this was exactly three years from his earlier departure. He chose to cross the Khasia Hills again, as he had done with Wallich, but varied the route. From Gauhati, he went with the Mission which penetrated the mountains northwards to a depth of about 80 miles, then turned west and crossing high passes, one of 12,500 ft., regained the plains by the Buxa Duars as the rains of 1838 were commencing. Jenkins would have liked to keep Griffith in Assam; but the Governor-General, Lord Auckland, had other work for him and attached him to the army of the Indus which was preparing to march on Kandahar. Lord Auckland expressed the wish that the military authorities would give Griffith every liberty consistent with safety.

So Griffith, leaving Calcutta, went over the northern plains to Ludhiana from which he wrote that he would rather be in Lower Bengal than in a sandy place where the flora was so sparse. He followed the Sutlej to the Indus and the Indus to Shikarpur; then went with the army through the Bolan Pass to Quetta, botanized all the way to Kandahar and from Kandahar to Kabul. When he left Afghanistan, it was by Peshawar. If a map be consulted it will be seen that he went round the central massif, not through it; but he reached considerable heights in the north-western parts of the country. When the army was being withdrawn, he asked leave to remain with surveyors who were finishing their work; and this was granted. He stayed until it was unsafe to stay any longer; and the last part of his exploring was in the latitude of Kabul, which he examined very thoroughly. Unfortunately he had a long illness during this extension of his time, suggesting that his excellent constitution was not completely proof against the strains that he put on it. He made many friends among the officers who were prepared to collect for him; otherwise he engaged local men to collect and bring plants to him. It is noteworthy how many of the officers who collected were men of note for their ability. These he records as giving him dried plants. Firstly the surgeon David **Ritchie** (1809-66). He had been a pupil of Robert Graham in Edinburgh. His service during this war took him to Herat whence he brought a collection to Griffith. Griffith, whose travels towards Herat ended at Kandahar, was particularly grateful for this, which, he remarked, proved to him that the flora of even the hottest parts of Afghanistan is European in character. Ritchie, though he published nothing, remained a collector through the rest of his Indian career, collecting in Bombay, Sind, the Punjab, and Central India, and the herbarium which he built up was given after his death to the Royal Botanic Garden, Edinburgh. Another co-adjutor was a surgeon on the Bombay staff named **Grant** who brought plants from Saighan to Griffith. Griffith acknowledges also the services of Captain E. **Sanders** who continued to collect for him until his death, shortly before Griffith's, and of Lieutenants Thomas **Hutton**, an excellent zoologist, and Henry Mortimer **Durand**, afterwards knighted for his eminent services. Sanders had collected for Griffith between Kandahar and Herat; and these specimens would have linked up with Ritchie's, but were lost in fording a river. Hutton and Durand collected chiefly about Quetta.

Griffith was not a man to miss an opportunity, and on his way back to Calcutta he doubled his easier marches to provide time for diverging northwards to Simla and Mussoorie, and southwards to Jabalpur. But the season was mid-winter and not good for collecting the flowering plants, though both divergings afforded him a glimpse of country that on no other occasion he could have seen. He had suggested travelling within the mountains the whole way from Kabul to Simla, but that was disallowed. Evidently by visiting Jabalpur, he enlisted the help of Donald **Macleod** who was at the time Principal Assistant to the Commissioner at Jabalpur; and Macleod made a collection for him. William **Munro**, mentioned earlier as having commenced collecting in Coorg, was about this time at Agra whence he sent specimens to Griffith. Griffith, unable to visit Nagpur himself, sent a collector to that place. Further he had material thence from Markham **Kittoe.** Kittoe earlier had been sent from Orissa to enquire into a report that coal was available inland; he collected then and at various places at various times between the Circars and Nagpur.

Another illustration of Griffith's intention to get collections from places that he could not visit is his sending of collectors from Calcutta to Darjeeling in 1843. He kept a personal collector for years in the Khasia Hills. All this was done to make his 'Flora Indica' as extensive and complete as possible. He relied on Wight for the Peninsula.

When Griffith had arrived in Calcutta from Afghanistan, he occupied himself in sorting and arranging his collections, eliminating to some extent duplicates from which Sir William Hooker and Lemann profited; but Lemann passed what he received to Bentham. Meanwhile he was appointed surgeon at Malacca, an appointment which pleased him as promising leisure, and a delightful flora. The forest began only four miles from the town and from his dwelling he would see the alluring outline of Mount Ophir. Within a very short time of his arrival at his station, Sir William Norris came from Penang to botanize with him on that mountain. In 1842 Wallich's health gave way and Griffith was summoned to Calcutta to take charge of the Garden. Wallich's departure was urgent; and as time was needed for Griffith's journey **Voigt** was invited from Serampore to bridge the gap. Griffith arrived at the beginning of December 1842. It was a bad day for the Garden when this happened, for he proved to be quite unsuited: he destroyed its amenities as a pleasure garden because it did not satisfy him as a taxonomic chart: he declared that the association of the two are incongruous. The consequences of what he did are given in the next section. His acting appointment lasted for exactly two years, save that he was only on his way to Calcutta during the first three months. Wallich returned from his leave in August 1844. Griffith, released by his return, remained in Calcutta, busy with his own affairs, mainly the arranging of his collections, preparing them for despatch to Britain where in the leave which could not be put off much longer, he would work on them towards his 'Flora Indica'. More duplicate material was eliminated to the benefit of Wight and Gardner in Ceylon. He arranged serially his Assam species under numbers 1 to 1,460, his Bhutan species 1 to 1,191, and his Afghan species 1 to 1,275. It would seem that the names of the actual collectors disappeared in the arranging. What happened to subsidiary localities is not evident. Then in December 1844 he returned to Malacca and had scarcely taken full charge of his duties when he was taken ill; and died (9 February 1845) from, it would be, those fell consequences of malaria that killed Jacquemont.

WALLICH'S SECOND PERIOD OF SERVICE AND THE DESTRUCTION OF THE FIRST CALCUTTA BOTANIC GARDEN

It is necessary to return to the year 1832, that is the year when **Wallich** resumed his post at the Calcutta Botanical Garden. This he did with diminished success, which may be attributed to a loss of health. My preoccupation, consequently, at the commencement of this section is Wallich's health. He had been declared ill at different times; he had been driven out of India in 1812, when he took a voyage to Singapore. His health was given as a reason for his taking leave in 1828. In 1830, Sir William Hooker wrote of him as 'greatly enfeebled by twenty years of incessant bodily and mental fatigue' (*Bot. Miscel.* 1, p. 42). Griffith in 1836, when with him on the Assam Delegation, recorded that he could not sleep and was in a nervous state, fearing that he would not return from Assam alive, and that his marches were so short as to be of only five miles. At the end of the Delegation, he almost fled from the country. Minutes of the committees on which he served tend to record absences. In 1842, he was driven by ill-health out of India and went to the Cape. When he returned in 1844, it was for no more than two years of work. Wight in 1845 wrote 'Wallich's botanical day is over'. In 1847, he left India for the last time. During the few remaining years of his life he distributed with Bentham's help a residuum of the great collections that he had handled so well during his leave of 1828-32. He died in 1854. The above justify the conclusion that Wallich, after returning from leave, was not the man that he had been.

I have had occasion to refer to his quarrel with Griffith. Rather unwillingly I have to refer to another, because of its bearing on happenings to the Garden. In the month of August, 1838, Wallich demanded the dismissal of his head gardener, J. W. **Masters**, accusing him of gross misconduct in abetting attacks on the management of the Garden. Masters protested; but the Government replied that discretion in the matter was with Wallich. And Wallich got his way.

John White Masters (*c.* 1792-1873) had gone to Calcutta to help in the carrying on of a school; at a date after Wallich's return in 1832, he was engaged by Wallich as Head Gardener in the Botanical Garden. After his dismissal he went to Assam and was given charge of Tea plantations as has been recorded (p. 61). When recording it, I called attention to the high character that he had. It is not possible to judge between Wallich and Masters; but it is necessary to note that Wallich was under criticism.

A writer called him 'Wallich who goes somewhere every year' implying neglect of his charge by absence; and the statement at one time was not untrue: in 1826, he had travelled through the sub-montane forests of Oudh; in 1827, in the teak forests of Burma; in 1828 he took leave and was away till 1832; in 1835, he was in Assam. But he had not been away between the Assam Delegation and the year of the dismissal of Masters. In the issue of McClelland's *Calcutta Journal of Natural History* of July, 1840 (1, p. 302), Wallich was editorially accused of neglecting the Garden; it is not said in what way. In the issue of July 1841 (2, p. 288), a more precise accusation is made. Wallich had reported to Government at the end of 1840 on what he called 'the exertions and progress which have been made during the last five years', detailing at great length the number of living plants sent out. The list is long enough to justify a remark that Royle printed at this time (Essay on the productive resources of India, 1840), to the effect that the influence of the Calcutta Garden had altered the horticulture of Bengal; but what the reviewer in McClelland's journal wrote was: 'Dr. Wallich seems unfortunately to be impressed with the idea that the introduction of plants into the Botanic Garden and the neighbourhood of Calcutta is the great object of the institution'. The reviewer develops only one complaint: it is that the Garden had ceased to have any field parties out collecting seeds and plants; but he means to say 'whatever the activity in horticulture, there is inadequate botany'. As already recorded, Wallich's health broke down so completely in August 1842 that he left India hastily and Griffith arrived towards the end of the year to act for him. **Griffith** immediately wrote a report on the Garden; and we, trying to read history, bringing the two fault finding statements in McClelland's journal alongside this report and remembering the intimacy between McClelland and Griffith, become convinced that the McClelland-Griffith combination issued the unsigned accusations. We may therefore examine Griffith's report and form an opinion on the accusation that Wallich had 'neglected' the Garden, which, I think, must be that ill-health had taken the energy out of Wallich, who was passing into a condition of marking time. Griffith arrived in Calcutta to act with his mind made up; he knew what he wanted. Printed copies of the letter that he wrote asking approval for what he would do bear the date 1 May 1843. But printed in his *Posthumous Papers* is a letter from him to Wight, dated 23 January 1843, which must have been written before the other. However, the month is of small importance. In the letter to Wight, Griffith tells him that he had the sanction of Government for his alterations; turning to the other letter we find the proposals. The Garden, he states, was 'literally choked with trees', some of them mutilated and some fallen. The students of the Medical College came weekly for a lesson in recognizing the sources of their drugs and for them the medicinal plants were labelled in Bengali; but otherwise there was no labelling. It had been a custom to dry specimens cut from plants when they flowered in the Garden and preserve them in a reference collection kept in a seed-shed where they could be looked up if the name of any plant were questioned. The plant names were otherwise retained in the memories of the older and more experienced staff (or misremembered). But Griffith found that the safeguard had been allowed to get into disorder. It had existed from early days, broken up by Wallich when he went on leave, renewed on his return, and then disordered. Griffith, rightly convinced of its importance, had the Garden collected over and not only made up a Garden set, but caused four others to be made which he was prepared to deposit elsewhere. Of the specimens which Wallich had had dried after 1832, Thomas Thomson said the labels showed that Wallich had had trouble in deciding what the names should be, so confused had the Garden records become. Griffith stated that the library was also in disorder. Yet again, Roxburgh had laid out a Linnaean garden, i.e., a border of selected plants spaced to exhibit the Linnaean System of Classification; and it, too, had been in disorder before Voigt took over. It is very easy for such borders, where annuals are likely to be common, to get out of order by the scattering of their seeds with a consequent volunteering in wrong positions. Griffith says so much of disorder that his indictment was serious; and he could scarcely say so much without foundation. He asked for fundamental changes as well as corrections of what had gone wrong. He would gather into one place nurseries that were scattered about the grounds; he would replant so as to get related species in apposition and have a garden of the Natural System to contrast with the Linnaean System, as well as formal flower beds; he would fill the many small tanks with earth taken from one single large tank; the surface left over would be allotted to trees planted like with like; above all, he would build up a working herbarium—a public herbarium, he called it—in the top storey of the Superintendent's house, placing it there because the situation was airy. Roxburgh had asked for that top storey that he might very largely live in it, and it was only accessible through the lower private quarters of the house; Wallich had stored his dried collection in the basement, which one must say was thoroughly unsuitable but completely accessible. As to the reference collection in the seed-shed, Griffith asked that the Government would give 'rigorous orders' for its strict maintenance. Towards the 'public herbarium' he put aside a quantity of his own duplicates. He would increase it by sending out collectors, selecting them out of his staff; and he would do all without asking for additional funds. Of these proposals, he wrote to Wight: 'The Government have approved all my suggestions and plans for improvements of the Garden. My plans are for a Natural Garden (i.e., a border exposing the Natural System) flanked by a garden of medicinal plants and a garden illustrating the useful plants of Lower Bengal. The first will occupy a large circle or ellipse with interior circles or ellipses, the central, the smallest, for Acotyledons; the second for Monocotyledons and the two outer for Dicotyledons. Whatever this arrangement be, the same will be that of the flanking gardens. The situation in front of the Conservatory will be convenient for the Natural garden—trees and large shrubs will not be admitted; but they are to occupy other parts and be in groups of Natural Orders and Classes'. Then he adds: 'I apprehend, however, that all my labour will be thrown away for want of time to complete the work before the period of my acting appointment expires'. Then why did he begin it? His apprehension was right; Wallich returned in August 1844, and the work stopped. Griffith must have had to enlarge the open place in front of the Conservatory to accommodate his circles. Now these were in the full sun, trees excluded; and trees are the natural clothing of the land in a climate as that of Calcutta. Griffith had not thought things out; the shade loving ferns had a central position; and we find him later admitting to Wight that he was short of ferns that would tolerate the position. The impracticability of Griffith is evident.

Griffith found his teaching work heavy. He was of course new to it. He realised the need of a local Flora for the students, and suggested that he would write one. Such a work by Griffith would have been in the Natural System; but the Calcutta students were doomed to the Linnaean System for yet a very long while.

Wallich having resumed charge, Griffith moved into the residential part of Calcutta and busied himself until December completing the arrangement of his collections and packing what he would need in

London on the leave that he was anticipating. He had undertaken to get Voigt's *Hortus Suburbanus Calcuttensis* printed and had to see that through the press. His friends noted signs of bodily wear, but his mind was as vigorous as before; he warehoused his collections, married and went to Malacca where at once he reorganized his collecting. Then he became ill and rapidly worse. Alarmed at the prospect of the collapse of all his hopes, he willed the materials that he had assembled, dried plants, plants in spirits and copious notes, to the Company whose officers had encouraged him to go so far. It is interesting that transfer by will was required, and very interesting that he was individualistic in suggesting no botanist to take his work up. Wight, as soon as he heard of Griffith's death, suggested that a full set of Griffith's dried plants should be retained in India at Calcutta and even offered to mount the specimens. Like Griffith, he wished to see a public herbarium at the Garden. The Government accepted the printing and ordering of Griffith's notes and drawings and the making available of his collections of dried plants without specific plans for maintenance; and they entrusted the work to **McClelland,** Griffith's most intimate friend after Wight. Wallich becoming ill again, it was convenient to put McClelland in charge of the Garden temporarily, for he needed the Garden's artists and the Garden's facilities for arranging Griffith's material. Griffith, had he lived, was to be Wallich's successor; on his death the choice fell on Falconer who at the time was in Britain on leave, the length of which was extended on purpose to enable him to finish his examinations of the vast supplies of fossil bones that he had taken to London. McClelland, completely infatuated towards Griffith, now in charge of the Garden, resumed the remodelling of it on Griffith's plans. Sir Joseph **Hooker,** arriving in Calcutta in January 1843, saw the resultant desolation and wrote to Falconer to warn him of it (see Life and Letters, 1, p. 235; 1918). When he came later to write his *Himalayan Journals,* he put his impressions in this form (1, p. 3; 1854): 'Of the Gardens it is exceedingly difficult to speak; the changes had been so great and from a state with which I had no acquaintance. There had been a great want of judgment in the alterations made since Dr. Wallich's time when they were celebrated as the most beautiful gardens in the East, and were the great object of attraction to strangers and townspeople. I found instead an unsightly wilderness without shade (the first requirement of every tropical garden) or other beauties than some isolated grand trees which had survived the indiscriminating destruction of the useful and ornamental which had attended the well-meant but ill-judged attempt to render a garden a botanical class-book'. The Garden had been and still was a playground for Calcutta, perhaps then more so than later. It seems strange that Calcutta did not protest as the destruction developed; but, Hooker commented, Calcutta seemed to think little of its Garden. It may be recalled that the Garden had been known as 'Wallich's pet' in the twenties of the century. Granted that its condition had deteriorated then, had Calcutta lost enough of its pride in it to be indifferent, though the change in the form which it took must have been distressing? One feels exceedingly sympathetic towards Wallich who saw the ruin, and perhaps through his ill-health, felt powerless.

Wallich published very little during the second half of his service. Griffith, blaming him for not having brought back to Calcutta a set of his plants, said that he had prevented himself from the continuation of his work by depriving himself of the means of recognizing his own species. It has been suggested that Wallich, when distributing his plants from London, had entertained the idea of not returning to India, in which case he would not need to allot a set for personal use in India. The suggestion is plausible. When he found after returning that he had spoilt his means of recognizing the species that he had in the Garden, as already explained, he had it collected over and then found himself, as Thomas Thomson noted, in frequent doubt as to the proper names. Still more would he find himself in doubt in regard to wild species. Why were the growing plants without labels? Gardeners in Europe at the time used painted wood or stamped strips of lead for labelling what they grew. It had been possible with a larger effort to do something in Calcutta; but there is no record of Wallich having tried to label the species. He seems to have considered quantity of species in the Garden his aim rather than quality, and that would mean retention though unhealthy (as in the case of the Tea bush) of that which did not stand up to the saturated soil and excessive humidity, the trees that Griffith said were 'fallen'.

In regard to the absence of a working herbarium, it seems that Wallich did not wish for one. He told Sir William Hooker how difficult it was to take care of dried plants; he collected sparingly when in the Khasia Hills with Griffith, and he retained no field collecting parties. But he could not avoid collection of dried plants being sent to him, just as they were sent to India House to be taken care of. Collectors assumed that he ought to do so. On his way back to Calcutta in 1832, Rottler, seeing him in Madras, gave him what would seem to have been the first bundles of a new accumulation. Vicary followed in 1833, in sending plants from Saugor. The Assam Delegation resulted in stimulating Jenkins to collecting. Schmid sent a small bundle. These and other gifts resulted in a collection of collections, which is a different thing from a working herbarium. The quantities increased from Griffith's time forward; and Thomas Thomson inherited charge of a not inconsiderable store when, in 1854, he succeeded Falconer as Superintendent of the Garden: he then made an inventory which he sent to the Asiatic Society of Bengal for publication (Journ. 25, p. 405, reprinted in *Hook. Journ. Bot.* 9, p. 33) and from it we learn what additions had come in to that date. Along with the bundles already indicated, the collection had held one of the three sets which McClelland had constructed from Griffith's material. Kittoe's gatherings had gone into it; there was a small bundle of plants from the District of Jessore presented by a missionary, J. **Barry**, a larger collection from Birbhum made by McClelland, Khasia Hill plants collected by the geologist Thomas **Oldham**, a smaller bundle from the same hills from the surgeon Joseph **Fayrer** (afterwards knighted), and plants both from the hills and the Assam valley from the pharmacist C. J. Simons; H. F. C. **Cleghorn** had sent plants from the northern districts of the Madras Presidency; and Gibson's herbarium from Bombay had been given; also Sind plants from Stocks, Jabalpur plants from R. H. Beddome, and Simla plants from Edgeworth. Vicary gave plants additional to his first gift. Thomas Thomson possessed a large herbarium of his own. It must be obvious from this that the botanists in India in general thought that there should be a working herbarium at Calcutta; but such a herbarium had never as yet been organized.

McClelland's last act, before surrendering his charge of the Garden in 1847, was to issue a Guide-book with a map, which is very difficult to interpret because there is no permanent feature in it except the great Banyan tree; even the river banks are not there. The map shows, of since lost features, Griffith's circles and the places allotted to 'orders and classes' in the arboretum, but does not give an idea how far these positions had become occupied. A list in it of species in cultivation is not for the garden as a whole and is in general unhelpful as a historical record.

When Sir Joseph Hooker was leaving India in 1850, he saw the Garden again with Falconer, now in charge, 'very busy . . . replanting the greater part of the grounds'. It was necessary to fill up tanks that by injudicious cuttings were destroying the most valuable parts of the land, to drain many acres and to raise embankments to prevent the encroaching of the river (*Himalayan Journals,* 2, p. 244; 1854). The Garden had had an internal economy by which its own need in timber, cordage, bamboos, etc. was met; this economy had been destroyed.

GRIFFITH AS A BOTANIST

Sir George King in an address to the British Association in 1899 said of **Griffith** (p. 6): 'No botanist (of India) ever made such extensive explorations nor himself collected so many species (estimated at 9,000) as Griffith did during the brief thirteen years of his Indian career; none ever made so many descriptions of plants from living specimens. His botanical predecessors and contemporaries were men of ability and devotion: Griffith was a man of genius'. This will not be disputed. Professor W. H. Land (in F. W. Oliver's 'Makers of British Botany', p. 179; 1913), estimating his calibre, calls attention to his prodigality of labour and to his penetration in search of facts. Griffith worshipped Robert Brown and Francis Bauer, Brown for his refusal to stop in taxonomy short of the ultimate power of his microscope, and Bauer for the faithfulness of his delineation. One may say that what he wanted was the absolute truth, and this from his 'teens. Thoroughness came to him as a student; he would let no character escape examination in the plant before him and he would examine every available plant to the limits of available time. Just before his death, he was seeking what he could do with a more powerful microscope than he had had. I have referred to the opportunities that he used at Sadiya for sitting at a table with pen and pencil, preparing the descriptions to which Sir George King referred, each description supported by drawings. These were material which McClelland had for publication; they were not, as they stood, ready for his 'Flora Indica', but for reference in writing the Flora when the opportunity should arrive. He condemned in strong terms the basing of a System of Classification, as Linnaeus had done, on a selected character. When Lindley brought into Botany the use of the word 'nixus' or 'inclination towards', its idea caught him; but Lindley's unremitting attempts at betterment did not. He would not venture a conclusion halfway as Lindley did. Otherwise, he was devoted to the Natural System with the conviction that Lindley would have taught him. His explorations with his microscope took him into fields of reproduction where he could not reach a solution; but he did his best (for this see Professor Lang's account of him). He was a wider student of plants than any contemporary in India; none but he attempted the determination of mosses. Ferns he collected with great assiduity, content to leave the naming to Sir William Hooker, who seems to have received more Indian material from him than from any one else. Animals he collected for others and sent them to the India House.

The preparation of descriptions, as at Sadiya, was a continuation of work that he was already doing at Mergui at the beginning of his Indian career. Arduous travel cut into his opportunities; Malacca he hoped would enrich them. He went there in 1841; a couple of years earlier, he had thoughts of long leave coming to him in 1842; at returning to Malacca, in 1844, he was sure that it could not be far ahead; and then he died in 1845, considerable preparations having been made towards the return to London, where only he could consult books and collections, which would ensure nomenclatural accuracy in his Flora. Incidentally, it must be mentioned that Sir William Hooker had moved his large collections to Kew when he was appointed Director of the Royal Botanic Gardens in 1841, and London offered unparalleled resources for what Griffith proposed. That he would have completed it is to me more than doubtful; he had no ability to measure time and the area of his target had become too large; it had become the flora of the whole face of Asia towards the Indian Ocean. Hooker's *Flora of British India* with its 14,500 species may be used as a measuring rod. It took the labour of Hooker for a quarter of a century, through which he commanded a great deal of assistance; and the design was compressed; but Griffith would have started. He does not seem to have estimated how many species he would be called on to describe, though he made some rough guesses at the sizes of his collections from various parts of India, 1,900 from Tenasserim, 1,700 from Assam, supplemented by a further 1,000 from his own personal collector, 800 from the Mishmi Hills, 1,000 from Bhutan, and over 1,200 from Afghanistan. The intensity of his examinations led him to observing the limits of variation and he declared that Variability had to be used as a character in defining species; some had it more than others. Such a conviction implied extension of his descriptions. He had a way of requiring the course of development and would have been an organographer rather than a morphologist had the distinction come in his time. He was so critical of past work that he wrote to Wight that he held, say, a third of the genera recognized as genera on sufferance, convenient for use but needing testing. He lived to work at generic level and sought to make them stable. Surely a great object!

THE INTERIOR OF NORTHERN INDIA

When the Afghan War was over, the officers who had dried plants for Griffith became scattered in cantonments towards the centre of India and mostly not remote. Ritchie returned to Bombay and then he was sent to Sind where he renewed his collecting; he made a considerable personal herbarium which, increased by many moves, remained in his possession until his death in Scotland in 1866. Hutton was sent to Neemuch in Rajasthan and Durand to Meerut, but probably these two did no more botanical collecting. Meerut, with a little diversified flora, had been the collecting place of several beginners. Finlayson had been there; Royle testifies to his collecting, but whither his plants went is not evident; Royle apparently began his Indian collecting at Meerut. The following also collected there: Falconer, Vicary, Thomas Thomson and Edgeworth. The last named was stationed in Bundelkhand towards the end of his service and explored the district of Banda with considerable thoroughness. Griffith, Macleod and Beddome have already been mentioned as collectors of Jabalpur.

EDGEWORTH, THE FIRST ECOLOGIST

Michael Pakenham **Edgeworth** (1812-51) was sent to Edinburgh as a student of languages when, as it happened, the present Botanic Garden was being laid out; and he found pleasure in watching the progress. There was no formal teaching, but a gathering of knowledge from William McNab who had the business in hand. Then he went out to India in the administrative service and was sent to the north-western plains. From Ambala, when stationed there, he made short journeys into the Himalaya and collected. At Ambala the daily tasks of administration focused his attention on the relations of crops to soils and then, extending his interest to the relations of the spontaneous plants to the same soils, he wrote a paper (*Journ. As. Soc. Bengal,* 7, p. 751; 1838) which may be regarded as the first ecological paper published in India. Edgeworth's other publications were taxonomic or dealing with geographic dispersal.

Among his friends were two who supplied him with specimens from deep in the Himalaya. One was Captain William **Hay,** Superintendent of the Hill States, with his office in Simla. He became Lord William Hay while still at Simla, and later the Marquis of Tweeddale. He travelled deep into the mountains towards the upper Indus, drying specimens which he gave to Edgeworth. The other friend was **Lance** who visited Spiti and Lahul and Dras to the north of the snowy barrier across Kashmir; and again the plants collected were given to Edgeworth. Edgeworth submitted these to Bentham through whose herbarium they passed to Kew. He was stationed for a time at Multan and investigated its flora thoroughly.

The ecological work next done in India after Edgeworth's was that of Hugh **Cleghorn,** whose first paper after he came to India was on hedges, the plants used for them and the plants that use them as situations (*Ann. Mag. Nat. Hist.*, 1, p. 435; 1850). Later, Cleghorn published an account of the sand-binding plants of the Madras shore.

THREE BOTANICAL EXPLORERS OF KASHMIR WHO WERE ALLOWED ENTRY DURING THE LIFE OF RANJIT SINGH

At the end of my first chapter (p. 877), I gave an outline of Jacquemont's visit to India, one summer of which he devoted to collecting in Kashmir. His success in gaining entry led to permission being given to two others, Godfrey Vigne and Baron Karl von Huegel. The latter has already been mentioned as having botanized in the Nilgiri Hills and in Ceylon. Godfrey Thomas **Vigne** (1801-65) had left Britain in 1832 without plans for a visit to the north-western Himalaya: this he explains in his book, *Travels in Kashmir* (1842); but the desire came after his arrival in Bombay at the end of a journey through Persia. He spent the summer months of 1834 in Simla, where he made contact with the three Gerards and with Sir George Everest, then the Surveyor-General; and perhaps the plan of his rough surveying came out of this. With Ranjit Singh's permission he entered Kashmir in 1835. Describing his baggage, he names a plant-press as part of his outfit; but there is evidence of its use in only two parts of his wanderings. In the same year Baron **von Huegel** obtained a like permission; and it happened that the two met in Srinagar and, having met, travelled together about the Valley and left together for Lahore. Vigne seems not to have collected plants in that summer; von Huegel probably did; if so, his specimens went to the Hofburg Museum in Vienna. He wrote a large book in four volumes *Kashmir und das Reich der Siek* (1844) in which there is no botany. Vigne returned to the mountains in 1836 and remained in them until 1838, during which time he collected in two places; one was on the edge of the Deosai plains near Dras and the other was in the Astor valley. When Vigne reached London he took his bundle of plants to Royle in which he was a bit late for Royle's convenience, as Royle had published almost the whole of his *Illustrations of the Botany of the Himalayan Mountains;* but Royle supplied Vigne with a short account of the flora of Kashmir, which Vigne printed as a supplement to his own book. Royle had found determinations of the species difficult in consequence of imperfect drying and rough handling; but he preserved the specimens which are in his herbarium at Liverpool. Determination today would be easier than it was to Royle in consequence of the flora having now become relatively well-known.

In 1836, Sir Alexander Burnes started on a Trade Mission for Kabul taking with him Hugh **Falconer,** the successor to Royle at Saharanpur. Circumstances altered the purpose of the Mission which, as far as Falconer was concerned, became one of economic exploration; and Falconer, detached at the Afghan border, tried to find a way up the Indus but after three marches was held up at Derband, deflected and passed into Kashmir, wintered there and in 1837 travelled via Tragbol and the Kishenganga valley to the upper Indus where he found Vigne, across the Indus near Skardo, and to Askoli, collecting all the way. Vigne's collection from Astor and Falconer's on his journey from Tragbol to Skardo were the first plants from the Himalaya towards its right-angle bend of the Indus. Royle, as said, could not do much with Vigne's plants, and it has to be added that Falconer's found their way into the back water of India House. But Falconer had his attention all the time on what he saw and wrote to Royle in London a long letter telling him of the plants that he had collected. The Linnean Society printed it in their *Proceedings* (1839, p. 7). Falconer followed Royle and differed from most of the earlier botanists in India in recording the localities whence his plants came; these were written in Persian or Devanagari script against his specimens; clearly he required his collectors to do this. Again following Royle, he paid special attention to anything economic. The Botanic Garden at Saharanpur, indeed, kept very closely to its first intentions and under William Jameson who succeeded Falconer in 1842 was little but economic. Falconer's earlier papers, with one exception, were on economic plants and in pairs. The information to give which was purely economic he put into a paper for the Agri-Horticultural Society in Calcutta, and the information of more narrowly scientific value he sent elsewhither. In this way, he wrote on 'Kut' or 'costus' (*Saussurea lappa* C. B. Cl. = *Aucklandia costus* Falc.), on asafoetida and on the paper plant, *Monotheca buxifolia* Decne, which he called *Edgeworthia buxifolia*. At heart Falconer was a geologist; it is recorded of him that as soon after landing at Calcutta as was possible he was in the Asiatic Society's Museum on a geological quest. His arrival in Saharanpur coincided with the discovery in the Siwalik rocks, through the digging for the Jumna canals, of plentiful bones of extinct animals and he made for himself a great reputation by studying them. A diligent collector of plants, he was more so a collector of these bones, so that when proceeding on leave in 1841, while he had 76 packages of plants, he had 5 tons of the bones; and when he had arrived, the plants were put into India House to be taken care of, and there they lay until after his death in 1865.

Griffith's death led to Falconer being appointed to the post of Superintendent of the Calcutta Botanic Garden. Wight had foreseen this, and wrote that he regretted how much more Falconer was a zoologist than a botanist. Falconer, after taking over, was soon required to go to Tenasserim to report on the forests and there he made considerable collections of plants.

PENETRATION OF THE HIMALAYA BETWEEN THE RIVERS SUTLEJ AND KALI

The reader will recollect that the first botanically minded visitor to this part of the Himalaya was General Thomas **Hardwicke** who went on a diplomatic Mission to the ruler of Garhwal, whose capital bears the same name, Srinagar, as the capital of Kashmir. Hardwicke entered the Himalaya at Kaldwara and followed a trail which crosses the mountains to the Alaknanda valley some thirty miles back in a straight line. The Alaknanda river is here at an elevation of about 1,700 ft. and flows westwards to enter the Ganges within the hills. The next penetration was a little further westwards; in it William Spencer **Webb** reached Jumnotri where the river Jumna takes its origin. His companion Felix Vincent **Raper** wrote a report on the travel (*As. Res.* 11, p. 449; 1810) which names various plants as observed to occur. This was immediately followed by **Moorcroft's** dash through the Himalaya and out on the Tibetan side at the Manasarowar Lake where the Sutlej has its origin. The plants which he brought back were sent to Robert Brown in London. Hardwicke's and Moorcroft's introductory contributions to a knowledge of the mountain flora were made before the Nepalese War of 1814-15. The peace made at the end of it enabled Webb to continue his survey and, as already recorded (chapter 1, p. 869), Wallich promptly placed his collectors Kamrup and Blinkworth under Webb's protection. Thus he reaped a harvest of hill plants. Botanizing in the Himalaya after this moved again westwards following the establishing of the cantonment of Sabathu and the associated sanatorium of Simla. The first permanent house at Simla was built in 1822. In 1817, that is to say before Simla came into being, the surgeon George **Govan,** not yet with the Garden at Saharanpur under his charge, travelled for a short distance into the mountains from Sabathu in the company of the surveyor **Alexander Gerard.** In the next year Alexander Gerard, starting again from Sabathu and joined by his brother **Patrick Gerard,** penetrated via Spiti as far as Shipke. Again a year later, i.e., in 1818, the then Surveyor-General James Dowling Herbert, taking Patrick Gerard with him, went by Kotgarh which is 40 miles east of Simla to Shipke.

An explanation is due for the termination of penetration at Shipke: Shipke is the place where Tibetan authority is met in this part of the Himalaya, a political terminus, but not the boundary of the Himalayan flora. Commonly, in human geography, highlanders flow over the rim of a plateau and this the Tibetans have done conspicuously in three places, the Chumbi valley between Sikkim and Bhutan, the Kyerong valley to the north of Khatmandu, and a wide-angled area on the east of Lahul in which is Shipke. It followed that at Shipke a number of early explorations were unwillingly terminated.

In 1821, Alexander Gerard with his surgeon brother **James Gilbert Gerard** visited the Shattul and Borendo passes. The next penetration, which was also in 1821, was a further move westwards; Moorcroft travelled via Kangra and Kulu into Lahul and forward to Leh in the Upper Indus valley where he remained longer than the Government thought reasonable, wintering there and emerging over the Zoji pass into the Vale of Kashmir. As before, he collected a little. On this occasion, the collection was sent to Wallich.

There were three Gerards. Alexander (1792-1839) had commenced surveying in the Punjab plains in 1812. In 1817, his work was transferred to the hills. James Gilbert (1794-1835) was in the medical service. Patrick (1795-1838) was an army officer, whose service was continuously in the hills. Of the three he made the closest relations with Wallich, and it was against a specimen which had reached Wallich from Patrick that the name *Pinus gerardiana* was written, in consequence of which Lambert stated that the pine was dedicated to him. The three brothers held closely together, and Vigne records spending an evening with the trio. Alexander wrote *An account of a journey through the Himalaya* (*Edinb. Phil. Journ.* 10, p. 295; 1824), i.e., of the journey to Shipke in which Patrick joined him. James wrote *An account of the Spiti valley and the circumjacent country* (*As. Res.* 18, p. 238; 1833). The three between them kept meteorological records at Sabathu or Kotgarh in 1817 and continued to do so for a long time.

Spiti proved to be the botanists' way into the remoter Himalaya from the front westwards of the Ganges.

Judged by the circumstance that Govan, when he returned to Scotland in 1823, took with him a collection of plants, it seems likely that in the trip of 1817 he collected, but that is not established. He did not record the trip; but he recorded another made through Nahan, the capital of the State of Sirmur (*Edinb. Journ. Sci.* 2, p. 277: 1828). At Nahan, he had a nursery as a branch of the Saharanpur Garden and therefore he must have had cause to visit it; but the elevation is only about 1,000 ft. above Saharanpur, and the climate can differ in little. Govan communicated plants that he collected to Wallich and they were distributed in the great distribution of 1828-32. His interests seem to have been mainly geological: but he could discuss mountain plants with the Countess of Dalhousie when they met in Scotland; and he had in his possession specimens which he could give to her. **Royle,** succeeding Govan at Saharanpur, found his medical work too heavy in his first years to allow him to leave the station, so he trained collectors to procure hill plants for him, but when he asked them to go as far as Kunawar they ran away. However, a good friend in the regiment stationed there, Lieutenant E. **Maxwell,** had a collection made for him. Wallich's tour of inspection of the Oudh forests in 1826, brought him as far as Hardwar and Dehra Dun, but not actually into the mountains. Mussoorie (so named from *Coriaria nepalensis,* the masuri of the hill men) took its origin from Dehra Dun, by an officer stationed in Dehra Dun building for himself a house. It was there before Wallich's journey. It was called the Potato patch from that valuable plant having been raised first in its garden. Royle soon had in Mussoorie a larger garden for acclimatizing, one of 40 acres, and therefore cause for visiting the station. He recorded no visits, nor any travel at all, save a journey to the summit of the Chur mountain through Sirmur in the direction of Simla. He closed Govan's Nahan nursery; the garden at Mussoorie was obviously much more serviceable. By 1828, he had plant-collectors more reliable than the first that he could send as far as the Vale of Kashmir in the company of home-going shawl pedlars. He used the pedlars also for procuring plants from Kashmir, surely on a large scale, for Jacquemont looked round the Saharanpur garden in 1830 on what he calls hundreds of plants from the Vale of Kashmir, which represented species that he had already seen in the hills, and guessed from their origin the elevation of the Vale before he had actually been there. In 1828, when Wallich was proceeding on leave, the artists of the Calcutta Garden were sent to work under Royle. If Royle had asked for them, it was because he had already planned to write his *Illustrations of the Botany of the Himalaya mountains;*

if he had not asked for them, then the use of them suggested the writing. The latter is the more probable because from the time of the arrival of the artists he redoubled his efforts to get material together. He ransacked the bazaars for trade products perhaps more assiduously than he had been doing, and he certainly intensified his field collecting. He sent collectors to Kashmir in 1829 and 1831 and in the latter year caused Kunawar to be explored again.

It is of interest that two of the friends who supplied dried plants to him, George William **Trail** and A. D. **Lindsay,** shared his economic occupations; the first was the author of an account of the rural economy of Kumaon and the second of a similar paper on the uplands of Pithoragarh, west of the Kali valley. Another friend who collected for Royle was James Stephen, an army officer who visited the Bamsaru pass, whereby one may get from the Ganges to the Jumna watershed. Another friend of the Army was a Major Cohen.

It has been recorded already (chapter 1, p. 877) that Jacquemont passed through Saharanpur when he first entered the Himalaya and left his collections to date in Royle's care; he called again to recover them. Another visitor to Saharanpur of the same year was a traveller who remains mysterious. Royle calls him Mr. R. **Inglis** of Canton and an address-list of members of the Asiatic Society of Bengal records his name with China as his country. He had travelled to Shipke; returning to the plains he called on Royle and showed him plants that he had collected. He did not give his collection to Royle, but sent it to Robert Brown. Robert Brown later, when Royle had settled himself in London and was working on his *Illustrations,* passed the bundle over to Royle for such use as he could make of it. Inglis's plants are in Royle's herbarium at Liverpool. It is intriguing to find a man from Canton, whom one cannot identify, going to the Tibetan border in the Himalaya.

Royle invited subscriptions to his *Illustrations* in quarterly parts and worked nearly to time in the years 1833-36; but fell out of time after that and did not get the last part out until 1840. Meanwhile, he had become Professor of Materia Medica at King's College. When the book had been finished he divided his specimens into three sets; the best he kept for himself and it is now at Liverpool; of the other two, he gave one to the Linnaean Society and he sent the other to Berlin.

Why did Royle from Saharanpur pay attention in particular to the Vale of Kashmir and to Kunawar? Because they were centres of population and his botanical collecting started with an economic bias.

The sanatoria, such as was Simla, brought botanists into the mountains who were less interested in the plant as useful than as something classifiable and satisfying to whatever urge to collect that was in them. The first of the Simla botanists was the Countess of Dalhousie who made a collection of about 600 species between April and October, 1829. Royle's friend, G. W. Trail, seems to have visited Simla at that time. Jacquemont paid three short visits in 1830 and Inglis one. The three Gerards were in and out of Sabathu. Then Lord William Hay had his office in Simla. G. T. Vigne spent the cold weather of 1833-34 there, but he probably did not collect at all. Baron von Huegel was there in 1835 and Vicary was at Sabathu, So far 10. The Countess's plants found a resting place in Edinburgh; Royle's along with what Royle obtained from Trail, Vigne and Inglis, are now at Liverpool; the Gerards' were sent to Wallich and so went into the great distribution; Hay's were given to Edgeworth who shared them with Bentham; von Huegel gave his plants to the Museum in Vienna, and Vicary's were sent to the Calcutta Garden, a scattering indeed! Continuing, Griffith paid his short visit to Simla in 1841 and his friend Captain Sanders, now a Major, was there. In 1844, General and Mrs. Walker made a collection in Simla which they sent to Sir William Hooker. In 1845 the Artillery officer, Edward Madden, was there and while he was there the first Sikh War suddenly broke out. On the eve of this, Prince Waldemar of Prussia who has been mentioned (p. 50) as touring in Ceylon with his botanist-physician, Werner **Hoffmeister**, arrived in Simla. He had visited Khatmandu and then penetrated the north-western Himalaya as far as Shipke, Hoffmeister ventured on to the battlefield of Ferozshah, where a musket ball from the Sikh lines killed him. His collections were sent to Berlin and there entrusted to Johan Friedrich **Klotzsch** for a report. Klotzsch decided that Hoffmeister had collected 456 species, to 108 of which he gave new names (Bot. Ergebn. d. Reisen des Prinzen Waldemar von Preussen; 1862). Scarcely ever has a worse piece of taxonomic work been presented to the botanic public: on the test, when it came in the working up of the *Flora of British India,* barely a dozen of Klotzsch's so-called new species were found good. The work is abundantly and well illustrated and that is its only merit. Hoffmeister had not labelled the individual gatherings and consequently even a geographic value is denied. Berlin and Kiel seem to have shared the specimens. In 1847, R. S. Simpson collected in Simla, and in June and July of that year Thomas Thomson was there awaiting his companions of the Kashmir Boundary Commission and had all the leisure that he could desire for collecting the flowering plants of these two months. These plants, which he collected with his usual thoroughness, went into the collections of Hooker and Thomson and so were distributed from Kew in 1855. Lastly, making 18 individual visitors in all, James William Grant needs mention to bring the Simla list to the year 1850. There was plenty of material for a Simla Flora by then, but no way of bringing it together.

Kunawar, because it is so accessible from Simla, received visits from Jacquemont, Inglis, Hay, Madden, Hoffmeister and Thomas Thomson; and earlier Royle, as recorded, had had it doubly collected over.

The hills west of Simla received less attention. Edgeworth collected in Nandi and Kangra. William Hawtayne Parish visited Nandi and Kulu in 1847, collecting in particular ferns, and added what he got to the collections of Hooker and Thomson. William Jameson (1815-92) of the Bengal Medical service, early in his Indian service, collected where Parish had been. He succeeded Falconer at Saharanpur in 1842, and held the post until 1875 with considerable effect in promoting the cultivation of economic plants, but with little further work in investigating the wild hill plants.

Beautiful collections were made on the western side of Kashmir by James Edward **Winterbottom** (1803-54). After taking a medical degree in Oxford, he spent his life in travel. In 1846, he went to Java and then returned westwards to India; proceeding to the north-west, he entered Kashmir through Hazara and travelled through the mountains to Astor, to Skardo in the Indus valley, and to Gilgit beyond. This was followed by a short visit to Khatmandu; and then he joined Richard Strachey to make his great journey to the sources of the Sutlej. Winterbottom returned to Britain, but set off wandering again and died away from home in 1854. His joint work with Strachey has its place in the next section; his herbarium remained in the possession of his family until 1900, when it was given to Kew.

A few words need to be said regarding work centred on Mussoorie. Naturally as Royle had founded a garden as a branch of his in Saharanpur, collecting in that direction remained an interest of Saharanpur. Falconer when he had succeeded Royle, sent collectors through the whole countryside up to the Niti Pass; and Jameson knowing that Hooker and Thomson contemplated a '*Flora Indica*' added material. Edgeworth had a period of service there.

THREE ATTEMPTS TO EXAMINE THE HIMALAYAN FLORA IN DEPTH

Early in the Survey of the north-western Himalaya the Ganges was a boundary between two fields of work: W. S. Webb, who had been the first in the survey of the mountains, was told to continue where he had commenced, and J. D. Herbert to survey west of the Ganges. That is how the latter came to journey to Spiti in 1819 (see p. 74). Botanical work followed the pattern of the Trigonometrical Survey, and there were two botanical journeys right through the north-western Himalaya, one on each side of the Ganges. A third was far away in Sikkim, with the whole length of the forbidden land of the Kingdom of Nepal separating it. It was a need of fixing the northward limits of Kashmir that evoked the Commission of Major Alexander Cunningham, Dr. Thomas Thomson, and Captain Henry Strachey on Herbert's side of the Ganges.

Thomas **Thomson** (1817-78) had been a pupil of Sir William Hooker in Glasgow and a fellow-student of his son Joseph Dalton Hooker. He entered the medical service in Bengal and was sent to the northern plains (1839) where he botanized diligently through Rohilkand, whence he made short trips into the Himalaya. In 1847, orders came to him at Ludhiana, where he then was, to proceed to Simla to join the two named with him above for the purpose of examining the most northern mountains at the back of Kashmir. He had to wait until August before the three could start; then they took the road through Kunawar to Spiti, where Henry Strachey left the others that he might proceed to the upper part of the Indus, where he was to survey; Cunningham and Thomson directed their way towards Leh, where they parted. Thomson's work was to explore the routes from a little above Leh down to the right-angled bend below Rondu, and also the valleys of Nubra and Shyok. He was caught by winter and compelled to stay at Skardo until the Zoji Pass was passable. He crossed it to the Vale of Kashmir, only to ask for a second season in the parts where he had been. He returned through Zanskar and going beyond the Indus visited Karakoram. Thomson must have gathered practically all the flowering plants that occur in the parts that he visited, just as Griffith had gathered practically all to be had about Kabul.

Henry Strachey (1816-1912) was the elder brother of Sir Richard Strachey. He did not possess the zeal for collecting of his brother but enough to make him collect, though sparingly. He did a work of most arduous surveying. He had visited the sources of the Sutlej in the year before he was put on the Commission (*Journ. As. Soc. Bengal,* 17/2), and in 1847 he went to the sources of the Indus.

Richard Strachey (1817-1908; afterwards Sir Richard) had entered the Bombay Engineers and transferred to the Bengal Engineers. He was sent to the Jumna Canals until, in 1846, the survey of Kumaon was entrusted to him.

In enumerating the Simla botanists I have named Edward **Madden**. He (1805-56; ultimately a Lieut.-Colonel) had developed a great interest in mountain passes, perhaps initiated by considerations of mountain warfare; and, immediately after the Sikh war, we find him visiting the Shattul and Burum passes (1845), and later the Pendras pass (1846), and then the Pindari glacier. He collected plants on these expeditions and described his experiences in the *Journal of the Asiatic Society of Bengal* (15, p. 79: 16, p. 226). Illness caused him to go to Almora, where he met Sir Richard Strachey who was commencing his survey. A common interest resulted in a joint paper. Madden retired and in retirement he became President of the Edinburgh Botanical Society; and he gave his official presidential address to the Society on the distribution, chiefly altitudinal, of trees in the Himalaya. After retirement, he had been sending dried plants to Kew. Strachey in the course of his survey was at the Pindari glacier a year after Madden and again in the next year. In 1848, Winterbottom, having left Kashmir and having made a short visit to Khatmandu, joined Strachey to proceed from Almora to Milam and over very high passes to the Manasarovar Lake, the source of the Sutlej, at 15,000 ft. As stated, Winterbottom made beautiful collections in Kashmir and now, with Strachey, did the same in Kumaon and within the limits of Tibet. Not only were the dried plants well selected, the labelling was excellent. Strachey returned to Britain and spent 1850 determining his species and then distributing sets of them with a printed list. This list was reprinted in Atkinson's *Gazetteer of the North-west provinces of India* (II, 1882) and, after a revision of the names by Duthie and others, republished in 1905. It is said of it in the introduction rightly that it gives a cross-section of the Himalayan flora from the plains of Rohilkhand to the loess plateau of Tibet.

The third cross-section, that of Sir **Joseph Hooker** in Sikkim, was all but contemporaneous with the two in the north-western Himalaya. Joseph Dalton Hooker (1817-1911; knighted in 1877) was the second son of Sir William Hooker. Having decided on the outlines of his travel, he arrived in India in January 1848, at which date Thomas Thomson was in the remoter parts of Kashmir, and Strachey, arranging for but not yet engaged in his great journey to the Manasarovar Lake. He made his way through Chota Nagpur and by Patna and Purnea to the Sikkim Himalaya and established quarters at Darjeeling. Then he commenced an intense effort to acquaint himself thoroughly with the plants obtainable there through the activity of a crowd of up to 18 collectors. In a letter to his sister (Life and Letters, 1, p. 260), he described his morning's work, the arrival of the collectors with the spoil of the previous day in baskets on their backs, himself preparing labels, setting aside that to be drawn and that to be dried. When he felt that he had started this well, he made a short trip to the mountain of Tonglu. When the autumn had come, he made the first of his journeys through the mountains. With sanction he entered Nepal and travelled up the Tambur valley, that is to say on the further side of Tonglu and Kinchinjunga, to the passes into Tibet. This occupied him from the middle of October to the middle of January, when he regained Darjeeling over the Islumpo Pass and through Pemionchi. Then followed an early spring collecting of the plants of the outer hill faces to secure what had been missed in the previous year. At the commencement of May he started up the Tista valley and spent the summer close to the political boundary of Tibet. The two thrusts, one up the Tambur and the other up the Tista, were not so remote from each other as were Thomson's and Strachey's, and phytogeographically may be counted as one. Hooker went to the frontier in two successive years and so did Thomson.

Hooker would have liked to spend the next summer in Nepal, but that could not be arranged. Instead, Thomson joined him and they moved the collecting to the Khasia Hills where they worked with great intensity from early June to late November. While they were there, Thomas **Lobb** (see p. 55) passed by with his train of collectors of living plants. I do not know what motley of transport he was using, but it tickled the imagination of Hooker to call it Lobb's circus. From the Khasia Hills, Hooker and Thomson moved to Chittagong, then to the Sundribans and so to Calcutta. Both returned to Britain in 1851. Their collections were pooled, worked up into sets, and distribution began in 1855, distributed just as Wallich's were to secure international agreement in nomenclature; Thomson worked up his diary into his book entitled *Western Himalaya and Tibet* (1852), and Hooker wrote his *Himalayan Journals* (1855); the two conjointly issued the first volume of their projected *Flora Indica* (1855). Then lack of financial support compelled abandonment. As the first 280 pages hold a valuable review of the state of knowledge of the flora of India, making it much more important than the rest, it is a pity that we cannot alter the premature title.

Sir Joseph Hooker had been able through his father to arrange from India for the publication of his *Rhododendrons of the Sikkim Himalaya;* and the parts followed one another from 1849 to 1851. It is appropriate here to mention John Ferguson **Cathcart**. He (1802-51) was of the administrative service in Bengal, where he collected a herbarium; and it was his pleasure to employ an artist to make plant-portraits of the most striking flowers, much of the work being done in Darjeeling. After his death the plant-portraits were given by his sister to Sir Joseph Hooker who used them for the *Illustrations of Himalayan plants selected from drawings made for the late J. F. Cathcart.*

The combined collections of Hooker and Thomson were computed at 150,000 specimens, representing roughly 3,500 species from Sikkim, 3,000 from Khasia Hills, about 1,000 from the plains of north-eastern India, the same number from the plains of north-western India and lastly 2,000 from the north-western Himalaya.

As soon as it was known that the two would write a Flora, help flowed in. The collecting of Jameson has been mentioned; James William Grant sent plants from Kunawar; Jenkins and his associates in Assam increased their collecting; Falconer, now in Calcutta, sent so many men to Khasia to collect that Hooker suggested the path-sides were becoming stripped of vegetation; the Government of France responded with a set of Jacquemont's plants, and Andrew **Fleming**, a geologist then mapping the Salt Range, sent a considerable collection.

While Hooker and Thomson were busy tidying their work by distributing their duplicates, Wight happened to retire, bringing to London his last collections. Wight made these up into sets which were distributed from Kew in continuation of the Hooker and Thomson sets. Hooker contrived to get out of India House Falconer's 76 boxes of dried plants deposited in 1844 and these, somewhat deteriorated by their 20 years of waiting, were distributed also.

WESTERN INDIA

In my first chapter (p. 873) the progress of the Bombay botanists was carried to the publication of John Graham's *Catalogue of the plants growing in Bombay and its vicinity*. A mistake was made there: Dr. Lush did not work in Ratnagiri, but in Poona. The error, which is regretted, has been corrected in this journal (52, p. 228). **Lush,** who had taught in one of the London medical schools before he went to India, was perhaps the first experimental worker on cotton, antedating Wight's work; but Wight's lasted longer. Lush had experiments not only in the Dapuri Garden but in Khandesh and in Dharwar. He published on cotton in 1835 or shortly before Wight had charge of experiments.

Alexander Gibson succeeded Lush at the Dapuri Garden in 1838. He had arrived in Bombay three years before John Graham. John Sutherland Law had arrived two years before and Lush one year before. John Graham was in Bombay 11 years before the publication of his *Catalogue of Bombay plants;* Lush 12; Law 13; and Gibson 14. Before any of these were in a position to study the Bombay flora, William Henry **Sykes** (1790-1872, ultimately a Lieut.-Colonel), an excellent man of business and a zoologist of considerable competence, collected plants in the Deccan, chiefly about Poona. He held the post of Statistical Reporter, Bombay, from 1824 to 1829, but continued to collect to 1831. Wallich indicated on the map that ends his *Plantae Asiaticae Rariores* his travelling. The collections amounted to about 1,000 species. He did not study them; but John Graham had the use of them and Gibson also. They were given to the Linnaean Society and the Society asked Royle about 1840 to make determinations. In 1863 when the Society withdrew from curating small collections, Sykes's was sold and found a home in the herbarium of van Heuckx in Antwerp.

Joseph **Nimmo** seems to have been born in India, his father the captain of a ship trading in and out of Surat or Bombay, but this is a surmise. As a young man he was in Government service at Surat (1819), but lost his appointment; and it is not known what his employment was later. His means were apparently restricted and, in correspondence with Sir William Hooker, he more than once apologised for not being able to do more collecting. Wight, with whom he corresponded, thought highly of him; he corresponded with Royle also, seeking determinations. Wight indeed calls him 'the acknowledged head of the corps botanique of Bombay—a gentleman whose diligence in collecting is only equalled by his liberality in distributing the proceeds'. I think that Nimmo must have had a greater influence than appears on the surface and perhaps saw Graham through the accumulation of data for his Catalogue as he finally finished it and saw it through the press. John Sutherland **Law** (1810-1855) was born in India (as were Royle and Hugh F. C. Cleghorn) and resided in India from 1829 to 1854, firstly at Thana, and later at Dharwar or Belgaum. He made a considerable herbarium by which Gibson much benefited and was generous in giving plants to Sir William Hooker and to the Oxford Garden. Alexander **Gibson** (1800-67) did considerable service for Botany in the Bombay Presidency. The Government employed him as a vaccinator in the Deccan and in Khandesh; and that wandering employment brought to him a most intimate understanding of village life and the plants of the open country. He seems to have been at the beginning rather a lone figure, as Wight was, and it was Law who helped him out of that. When Graham's *Catalogue* appeared Gibson checked his collections by it. A year before it came out he had written his *General sketch of the Province of Guzarat* (*Trans. Bombay Med.-Phys. Soc.*, 1, p. 1; 1838), and in the same year he was put in charge of the Dapuri Garden at Poona. Two years later he published a report on Teak (*Trans. Bombay Agri.—Hort. Soc.* 1840, p. 120) and a year later reports on Senna and Tobacco. Six years after this (1847) he was appointed Conservator of Forests and held the post until retirement in 1860. He was the first of such officers that India had; the attempt, very much earlier, to arrest the over-exploitation of the Teak supplies having been a police measure which proved ineffective. Gibson as a forest officer was after a time to have Dalzell associated with him. Nicol Alexander **Dalzell** (1817-78) arrived in Bombay in 1841, at which date Gibson was not yet a forester, but a promoter of any kind of crop likely to be useful, i.e., he was in charge of the Dapuri Garden. Dalzell had an Edinburgh degree but not in Medicine, and he took an appointment in the Custom House, botanizing in his leisure. Next he took a subordinate position in the Forest service and worked his way up. He intercalated descriptions in a copy of Graham's Catalogue; they were sketchy, but Gibson approved of them and financed the printing. In this way, Dalzell's and Gibson's *Bombay Flora* originated (1861). It is Graham's Catalogue expanded. Bombay had a second vaccinator-botanist; this was John Ellerton **Stocks** (1822-54), a pupil of Lindley, with a medical degree. He reached Bombay in 1847 and was sent to vaccinate in Sind. A year after commencing work there, he found it possible to reach Shah Bilawal in Baluchistan (see Hook. *Lond.*

Journ. Bot. 7, p. 550; 1848) and a year later to go as far as Quetta and Nushki (Hook. *Journ. Bot. and Kew Miscell.* 2, p. 303; 1850). Griffith had been to Quetta a year before Stocks, but there was this difference between them, Griffith came by the Bolan pass, but Stocks from the southward. In 1852, Gibson being on leave, Stocks acted as Conservator of Forests, having charge privately of Gibson's herbarium which he enriched. In 1853, he brought his personal collections to Kew to work on them, but died in 1854.

Dalzell succeeded Gibson as Conservator of Forests in 1860. Gibson's plants were given to the Calcutta Garden. The line of botanists in charge of the Bombay forests was continued by the appointment of Eyre Champion **de Crespigny** (1821-96). He had reached India in 1845. The posts of Conservator of Forests and Superintendent of the Dapuri Garden were combined in his case. He made a herbarium which is now at Manchester. So also is a Bombay herbarium of ferns made by another medical man, Andrew H. Leith.

On p. 62, I referred to David Ritchie (1809-60), a surgeon of the Bombay service, as providing Griffith with dried plants from Herat. He during 35 years, 1831 to 1866, collected considerably. In 1838 he was in Afghanistan; later at different dates he was in Sind, the southern Mahratta country, the western Punjab, and Central India; and his collections were in his possession at his death. Then they were given to the Royal Botanic Garden, Edinburgh.

During the period under review, Herbert John **Giraud** reached India (1842) and became a teacher in the Grant Medical College; and Bernard Kaspar Kamphoven, a Danish botanist, visited Bombay (1845) and made a collection which is at Copenhagen, with duplicates at Kiel.

WIGHT'S IMMEDIATE SUCCESSORS IN MADRAS

Wight was in India to the last years of this chapter; among those who joined him the most conspicuous was Hugh Francis Clarke **Cleghorn** (1820-95). He had been born in India, and had received a medical degree in the University of Edinburgh and with it returned to India in 1842. It has been recorded that Wallich was nominated Professor of Botany in the Calcutta Medical College in 1837; Giraud, as recorded in the last section began teaching in the Grant Medical College and had the title of Professor of Botany in 1845: Cleghorn was made Professor of Botany and Materia Medica in Madras in 1851, where judging by his versatile writing, he was assuredly an inspiring teacher. So too Giraud seems to have been. Cleghorn in his first years collected plants in the northern parts of the Madras Presidency which were sent to the Calcutta Garden. In 1856, he left his teaching for the post of Conservator of Forests and was finally Inspector-General (1867). His herbarium is at Edinburgh.

A less purposeful collector of Madras of these years was Gideon Thomson, a younger brother of Thomas Thomson. He made large collections through collectors which passed into his brother's possession and then were distributed through Kew. A resident in Tinnevelly, L. D. Thomas, sent a small bundle of plants to Sir William Hooker in 1844.

Mosses Studied; but Lower Cryptogams Await Further Development of the Microscope

Francis Buchanan collected a few mosses when in Nepal in 1802. Edward Gardner, who was Resident at the Court in Khatmandu in 1820, collected more, and after him Wallich. Royle collected some in north-western India; and Wallich had 113 numbers for distribution when in London. Sir William Hooker had commenced describing Indian mosses in 1820 in his *Musci exotici*, and with Robert Kaye Greville continued this in the *Edinburgh Journal of Science*, 1-3 (1824-25).

At the other end of India Schmid collected mosses in the Nilgiri Hills and gave them to Zenker at Jena, who, when he died in 1848, had done nothing with them. **Karl Mueller** of Halle, obtaining possession of these, described them in 1853, twenty years after their collecting. Schmid, on receiving a list of the determinations, just before his death passed it over to the Madras Society for Literature and Science: and it appeared in their journal (19, p. 84; 1858). Perrottet collected in the same part of India and his specimens were worked up by **Montagne** (*Ann. Sci. Nat.* sér. 2, 17, p. 243; 1842). Wight collected on occasions. **Griffith** collected mosses vigorously in the Khasia Hills when on the Assam Delegation and worked them up when at Sadiya. He alone in India touched their taxonomy; otherwise the naming of Indian mosses required that they be sent to specialists in Europe. William **Mitten** made a complete review of these plants as known to him from India in 1859 (*Journ. Linn. Soc.* Suppl. 1). He names the following as collectors: Bélanger, Booth, Buchanan, Foulkes, Edward Gardner, George Gardner, Gough, Griffith, J. D. Hooker, Law, Mack, Maxwell (a Ceylon collector), McIvor, Parish, Perrottet, Royle, Schmid, Richard Strachey, Gideon and Thomas Thomson, Walker, Wallich, Wight and Winterbottom. It is evident that the date for study of the mosses had come; and it may be commented that students of them had contrived to get them into fair order without much magnification.

So too the date for the study of the Hepatics had come. The collectors of mosses were prepared to collect Hepatics also. Falconer went further and published in 1851 a new genus. Through the years 1844 to 1847, **Gottsche's, Lindenberg's** and **Nees Von Esenbeck's** *Synopsis* was in course of publication. It occupies a place parallel to Mitten's review of the mosses. By the number of Indian species known to these authors, Wallich comes first, and Perrottet second.

Of Algae and Fungi there is little that need be said. Rottler had collected some of the larger seaweeds; Strachey and Winterbottom had collected lichens to which Churchill Babington gave names. Royle did not let Chara pass unnoticed. Bisbee has occupied himself in a search into references to fungi (see Butler and Bisby in Sci. Monogr. no. 1 of Imp. Council of Agr. Res., 1931).

Fellowship as an Aid to Individual Effort

To this point the investigations of botanists in India have been referred to as the occupations of individuals; and their corporate efforts kept in the background. Wight called a friendly working together of the Tranquebar missionaries a botanical Society, but surely there was no scientific society as such bodies are understood. The missionaries were united as missionaries, and the words 'United Brothers', which Wight indicates as the name of the society, was no more than a name for the Moravians to which these missionaries belonged. As United Brothers, they agreed to using this as the name of the Mission to transmit dried plants to Banks. Instead of the United Brothers, the first Society formed in India was the honoured Asiatic Society (of Bengal) which Sir William Jones called into being in 1784 or two years before the founding of the Calcutta Botanic Garden. Its business was to be learned; and Science was within the ambit of its learning. The Society's journal, *Asiatick Researches,* the first volume of which appeared in 1788 contained one botanical paper. The Society asked that communications to it be polished, expected them to be of some length, and hedged their printing with rules that made it very deliberate, so deliberate that the founder's aspiration for an annual volume devolved into a volume at an interval of, on the average, 2¾ years. That was not a marching with impatient Calcutta, and, when the Society was about 30 years old, provoked demands for a change, a dropping of some of the dignity for the sake of a quicker return. In what group of members protest was strongest, I do not know; but one botanist, William Jack, isolated in Sumatra, recorded his wish for a journal that would accept and print quickly notes that needed record such as if not recorded tended to delay larger things, and in his words encumbered his work. Though the Society in the third decade of the 19th century debated its course, it at that time somehow could not contrive reform, or rather its attempt at reform led nowhere. Carey's Agri-Horticultural Society had in 1829 started the printing of *Transactions* and took papers with an economic appeal, somewhat relieving the pressure for reform. Further relief came in an interesting way. James Dowland Herbert, who has been mentioned as surveying in the north-western Himalaya, being in Calcutta as the Deputy Surveyor-General, started in 1829 at his own risk a little venture called *Gleanings in Science.* It came out monthly and had a popular appeal. In 1830, he left Calcutta putting the *Gleanings* into the hands of a relatively new man, James Prinsep; and Prinsep in 1830 was elected a Secretary (there were two) of the Asiatic Society. To him it occurred as of advantage to make the *Gleanings,* which punctually recorded the proceedings of the Society, into an organ of the Society. The council consented. The punctual *Gleanings* now became the *Journal of the Asiatic Society* (he added *of Bengal*) and made a way for prompt printing. The gain was never lost and the *Asiatick Researches* slowly died.

In Madras in 1834, the Society for Literature and Science commenced a journal parallel to the *Journal of the Asiatic Society of Bengal* as an outlet, and an Agri-Horticultural Society was formed in 1836 likewise providing an outlet. Bombay had done similarly slightly earlier. Wight used the *Madras Journal of Literature and Science* during the years when he was in Madras; and Gibson made use of the Bombay Agri-Horticultural Society's *Transactions* for the publication of his paper on Teak.

The Surgeons had societies of their own in all three Presidency cities, and if, as they sometimes did, they printed a botanical paper they were not out to help the botanists. The few occurrences that there were need not be named. Bombay had a Geographical Society which printed a paper on the rural economy of the District of Ellichpur, but not another with the slightest botanical interest.

In 1840 McClelland seems to have thought that the biological sciences might sustain a quarterly and began his *Calcutta Journal of Natural History*. This was premature, and publication ceased in 1847. McClelland after three years secured as co-editors Griffith (1844), Wight (1846), and George Gardner (1846), who were obviously glad to have the outlet; but their competence did not save it. All other publications printing papers on Natural history had the backing of an association of members behind them.

RETROSPECTIVE

Two men dominate this chapter, Wight and Griffith. The mantle of Roxburgh, left behind when he was transferred to Calcutta, may be said to have been picked up by Wight who extended the influence of Roxburgh's *Coromandel Plants* over the whole Peninsula. Griffith was the follower of no one who had preceded him in India; he came as a fresh impulse out of the school which was in a position to influence Botany in India. He showed no interest in economic botany which was a gate that helped a number of others to official recognition. To him the plants of India needed recognition, and that demanded all the energies which he used up with such prodigality. It was greatly to the credit of the rulers of India that they recognized and used his genius and that after his death they did what was immediately in their power to save as much as possible of his work.

Griffith's intensity of examination led him to turning over in his mind the implications of variability where he was probably halted by Swainson's dictum varieties 'do not perpetuate the peculiarities that they possess'. Swainson's writings had impressed Griffith.

Within the period, actually in 1835, the Company had decided on an educational policy in which taxonomic botany was recognized as needed in the medical schools; it was also recognized comtemporaneously as fitting a man for the control of experimental horticulture and preliminary forest conservation. Bombay's interest in supplies of Teak brought the last recognition to the front in Bombay.

The taxonomic outlay had got so far that ecology could appear, and with Sir Joseph Hooker's work phytogeography also. Furthermore, as I have suggested, the taxonomy was spreading from the large and obvious to the less easily studied mosses and hepatics, but the period left the still smaller plant-life virtually unstudied. Publication for the botanists seeking print became a little easier.

(*To be continued*)

MARINE NEMATODES FROM THE BAY OF BENGAL

I. PHASMIDEA

BY

RICHARD W. TIMM

Notre Dame College, Dacca, East Pakistan

(*With a plate*)

In January 1956 the writer made a large collection of free-living marine nematodes at Cox's Bazar, located on the Bay of Bengal below Chittagong near the Burma border. Most of the nematodes were obtained off Sonadia Island, a sand island about two miles from the mainland. The island has sand banks on its south side and broad mud flats on the north side. The prevailing current is from the southeast. The species reported here are of the Class Phasmidea, a group which is plant-parasitic, animal-parasitic, or free-living in soil and freshwater, but rarely in the sea.

Family RHABDITIDAE

Rhabditis (Choriorhabditis) marina Bastian, 1865 var. **bengalensis**, new variety

Description : Transparent body with fine striations ; lateral fields with six fine incisures, about 1/6 the body diameter wide, beginning just behind the stoma and ending just behind the spicule head. Six distinct lips with small papillae. Cervical papillae just above the level of the excretory pore. Stoma typical, 15μ deep, with conspicuous telorhabdions. Oesophagus with swollen corpus, slightly narrowed isthmus, and valvate bulb. Excretory pore just above the oesophageal bulb ; excretory sinus cell in the curve of the bulb. Testis extending almost to the oesophageal bulb, reflexed 218μ. Spicules 48μ long, cephalated, with internal division. Gubernaculum 20μ long. Bursa faintly striated, enclosing the tail tip. Genital papillae : 3 pairs of large preanal papillae, equally distributed ; 2 groups of 3 pairs each of postanal papillae. Fifth papillae turned outward at the tip ; all papillae extending to the bursal margin. Phasmids just behind the sixth pair of genital papillae. Tail 1.5 anal diameters long.

Male : 1.12 mm. ; *a*, 20 ; *b*, 5.8 ; *c*, 35.1.

Habitat : Living within a large clump of branching filamentous alga (*Siphonocladus*), collected from a sandy bottom in 1 foot of water at low tide.

Type locality : Sonadia Island, Bay of Bengal, Cox's Bazar, East Pakistan.

Discussion : This specimen differs from the published descriptions (e.g., Schuurmans Stekhoven, 1935 ; Meyl, 1955) and our own observations (at Woods Hole, U.S.A.) of the typical form of *Rhabditis marina* in the distribution of the preanal genital papillae. In *R. marina* the first pair of papillae is in line with the head of the spicules and the second and third pairs are close together just anterior to the anus. While there is variability in the female tail (Osche, 1954), the position of the genital papillae is a constant character. Therefore we are designating a new variety to embrace our unique specimen.

Family CEPHALOBIDAE

Halicephalobus new genus

Definition: Cephalobidae, Panagrolaiminae. Lips 4, distinct. Prorhabdions distinct. Meso- and metarhabdions broken or obscure; telorhabdions distinct. Oesophagus with well-defined median bulb. Isthmus shorter than corpus. Terminal valvate bulb. Prodelphic ovary, doubly reflexed. Differs from all genera of Panagrolaiminae except *Tricephalobus* Steiner, 1936, in the possession of a median oesophageal bulb, and from all other genera in the double flexure of the ovary.

Type species: *Halicephalobus limuli* n. sp.

Halicephalobus limuli new species

Description: Cuticle with fine striations, 1μ wide. Faint lateral fields, 1/8 to 1/10 of the maximum body diameter wide. Lips 4, distinct, the lateral lips seemingly confluent with the ventro-submedial. Stoma cylindrical, total length 11–12μ. Prorhabdions distinct. Posterior part of stoma almost as wide as the anterior part, inclined slightly ventrally. Ventral telorhabdion more prominent than the dorsal one. Ventral metarhabdion distinct and unbroken (in living worms); dorsal metarhabdions broken. Musculature surrounds the base of the prorhabdions Oesophagus composed of a long corpus, a swollen median bulb, a narrow isthmus, and a terminal valvate bulb. The nerve ring crosses at the mid-isthmus. The excretory pore is ventral to the nerve ring, just anterior to the terminal bulb. Cervical papillae located midway between the nerve ring and the terminal bulb. Phasmids indistinct, probably at 33% of the tail length. Prodelphic ovary, extending 12–17.2% of the body length forward, reflexing and extending 7.1–14.6% of the body length posterior to the vulva, then reflexing again to just before the vulva. Post-vulvar uterine sac lacking. One egg with shell in the uterus at a time, 52 × 18μ, with a large distinct nucleolus. Tail uniformly tapering to a tip, conical, 4.5–5 anal diameters long.

Female: 426–460μ; a, 20–21.3; b, 4–4.8; c, 6.7–7; V, 59.3–61.2%.

Habitat: Among algae and debris around the leg bases of the king or horseshoe crab (*Limulus*).

Type locality: Mouth of a small freshwater stream, Cox's Bazar, Bay of Bengal, East Pakistan.

Discussion: Four specimens of *Limulus* were collected in January, 1956, killed in 5% formalin in sea water, and preserved in a 5 gallon can with several fishes. After 5 months, scrapings of algae and debris were taken from the leg bases of the king crabs and examined. Hundreds of individuals of *Halicephalobus* were found, including many which were living and producing ova. The formalin at this time was still concentrated enough to preserve all the specimens in the can in good condition, but when living worms were transferred to fresh 5% formalin in distilled water they were killed. Some of the living nematodes were placed in tap water in a Petri dish, where they continued to survive and lay eggs.

Juveniles hatched out and grew to maturity, but there seems to have been no further reproduction. A few of the nematodes were still alive after 6 weeks. At no time were any males found, and reproduction seems to be without males.

Many members of the Family Cephalobidae have previously been reported from haline biotopes (e.g., Meyl, 1955). The commensal association of free-living marine nematodes with snails, crabs, crayfish, and gammarids is also well known (Baylis, 1915; Cobb, 1928; Chitwood, 1935; W. Schneider, 1932; Timm, 1951; Kinne and Gerlach, 1953).

Chitwood and Timm (1954) observed that *Rhabditis marina* can survive in either sea water or tap water. The writer has kept *Rhabditis ocypodis* Chitwood, 1935, alive for more than 6 weeks in both tap water and artificial sea water (3.1% saline). *R. ocypodis* is a commensal of the 'ghost crab', *Ocypode albicans*, on North Carolina (U.S.A.) beaches. Osmotic regulation or osmotic adjustment of marine nematodes has never been reported (cf. Krogh, 1939), but would make an interesting study. In unpublished experiments we have shown that *Paracanthonchus caecus* (Bastian, 1865) is poikilosmotic rather than homoiosmotic. Due to the impermeability of the cuticle osmotic adjustment does not take place through the cuticle, but probably is a function of the ventral excretory cell and, to a lesser extent, the intestinal cells.

Family TYLENCHIDAE

Tylenchus marinus new species

Description: Body cylindrical, transparent, tapering rapidly anteriad from the middle bulb and finely tapering posteriad from just behind the anus; posterior half of tail uniformly tapering to a fine point. Cuticular striation very fine, not observed on the head. Lateral field with 4 faint incisures. Head not set off, not supported internally by sclerotized pieces; cheilorhabdions unsclerotized. Stylet fine, 12.8μ long, without distinct basal knobs but with sclerotized attachment points. Oesophagus tylenchoid; middle bulb well set off, with small valves and weak musculature; somewhat expanded terminal bulb, not extending over the anterior end of the intestine. Excretory pore opposite the beginning of the terminal bulb. Ovary single, outstretched, extending almost to the base of the oesophagus; short post-vulvar uterine sac. Cervical papillae opposite excretory pore. Phasmid at the end of the conical portion of the tail. Tail 11.7 anal diameters long, with uncinate tip.

Female: 610μ; a, 32; b, 5.6; c, 6; V, 71%.

Habitat: Living in the top inch of bottom mud on a mud flat at low tide.

Type locality: Sonadia Island, Bay of Bengal, Cox's Bazar, East Pakistan.

Discussion: The systematic position of this species is difficult to determine since the male is lacking. The only known genus of marine tylenchs is *Halenchus*, represented by *H. fucicola* (de Man, 1892) Cobb, 1933; *H. mediterraneus* (Micoletzky, 1922) Cobb, 1933; *H. zosterae* (Allgén, 1934) Chitwood, 1951; and *H. mexicanus* Chitwood, 1951. The first two species have a hooked tail, as in our specimen, but the oesophagus of *Halenchus* is characterized by the presence of free oesophageal glands overlapping the anterior of the intestine. It also has internal cephalic sclerotizations and a striated lip region. The plant-parasitic genus *Ditylenchus* does not have such a lengthy tail. We are placing our specimen provisionally, therefore, in the genus *Tylenchus*.

ACKNOWLEDGEMENT

The writer is indebted to Dr. G. Steiner, University of Puerto Rico Agricultural Experiment Station, for his many criticisms and suggestions.

REFERENCES

Allgén, C. A. (1934) : Freilebende marine Nematoden aus Holland's Vaderö und der nahegelegen Küste Schonens (Südschweden). *Folia Zool. & Hydrobiol.* **6** (1) : 74–75.

Bastian, H. C. (1865) : Monograph on the Anguillulidae, or free nematoids, marine, land, and fresh water ; with descriptions of 100 new species. *Tr. Linn. Soc. London*, **25** (2) : 73–184.

Baylis, B. A. (1915) : Two new species of *Monhystera* (nematodes) inhabiting the gill-chambers of land crabs. *Ann. & Mag. Nat. Hist.* **16**, Nov. : 414–421.

Chitwood, B. G. (1935) : Nematodes parasitic in, and associated with, Crustacea and descriptions of some new species and a new variety. *Proc. Helm. Soc. Wash.* **2** (2): 93–96.

Chitwood, B. G. (1951) : North American marine nematodes. *Texas Jour. Sci.* **3** (4) : 617–672.

Chitwood, B. G. & R. W. Timm (1954) : Free-living nematodes of the Gulf of Mexico, *Fish. Bull.* **55**, Wash. : 313–323.

Cobb, N. A. (1928) : A new species of the nemic genus *Syringolaimus*. *J. Wash. Acad. Sci.* **18** (9) : 249–253.

Cobb, N. A. (1933) : New nemic genera and species, with taxonomic notes. *J. Parasitol.* **20** (2) : 81–94.

Kinne, Otto & S. A. Gerlach (1953) : Ein neuer Nematode als Kommensale auf Brackwasser-gammariden, *Gammarinema gammari* n. g., n.sp. (Monhysteridae). *Zool. Anz.* **151** (7/8) : 192–203.

Krogh, A. (1939) : Osmotic Regulation in Aquatic Animals. Cambridge, 242 pp.

Man, J-G. de (1892) : Über eine neue in Gallen einer Meersalge lebende Art der Gattung *Tylenchus* Bastian. Festschrift Rud. Leuckart, Leipzig, 121–125.

Meyl, A. H. (1955) : Freilebende Nematoden aus binnenländischen Salzbiotopen zwischen Braunschweig und Magdeburg. *Arch. f. Hydrobiol.* **50** (3/4) : 568–614.

Micoletzky. H. (1922). Neue freilebende Nematoden aus Suez. *Sitzungsb. Akad. Wiss. Wien.* Abt. 1, **131** (4/5) : 78–103.

Osche, G. (1954) : Ein Beitrag zur Kenntnis mariner *Rhabditis*-Arten (Nematoden). *Zool. Anz.* **152** : 242–251.

Schneider, W. (1932): Nematoden aus der Kiemenhohle des Flusskrebses. *Arch. Hydrobiol. u. Planktonk.* **24** : 629–636.

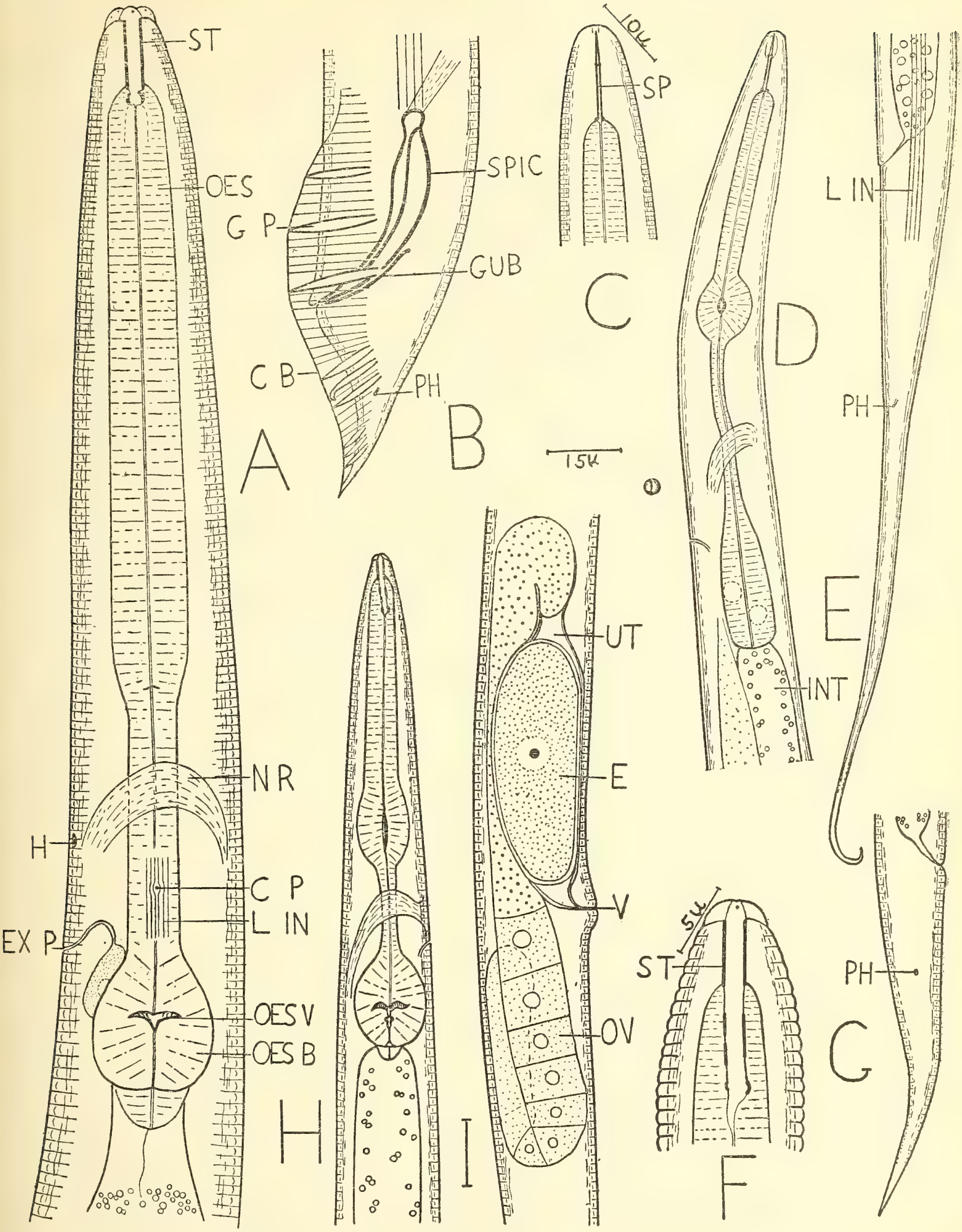
Schuurmans Stekhoven, J. H. (1935) : Nematoda Errantia. Die Tierwelt der Nord-u. Ostsee. T. V, b : 173 pp.

Steiner, G. (1936) : Opuscula miscellania nematologica. IV. 4. Observations on *Tricephalobus longicaudatus* (Bütschli, 1873). *Proc. Helm. Soc. Wash.* **3** (2): 74–80.

Timm, R. W. (1951) : A note on the cell inclusions of *Syringolaimus smarigdus* Cobb, 1928. *Proc. Helm. Soc. Wash.* **18** (2) : 125–126.

ABBREVIATIONS ON PLATE

C B — copulatory bursa
C P — cervical papilla
E — egg
EX P — excretory pore
G P — genital papilla
GUB — gubernaculum
H — hemizonid
INT — intestine
L IN — lateral incisures
N R — nerve ring
OES — oesophagus
OES B — oesophageal bulb
OES V — oesophageal valve
OV — ovary
PH — phasmid
SP — spear
SPIC — spicule
ST — stoma
UT — uterus
V — vulva


ST
OES
G P
SPIC
GUB
C B
PH
B
A
10µ
SP
C
15µ
D
L IN
PH
E
INT
NR
H
C P
L IN
EX P
OES V
OES B
H
UT
E
V
OV
I
5µ
ST
F
PH
G

Marine Nematodes from the Bay of Bengal

A—B. *Rhabditis marina* var. *bengalensis* new var. A. Oesophageal region. B. Male tail. C—E. *Tylenchus marinus* n. sp. C. Head. D. Oesophageal region. E. Female tail. F—I. *Halicephalobus limuli* n.g., n. sp. F. Head. G. Female tail. H. Oesophageal region. I. Female reproductive system.

(For abbreviations see end of text)

VEGETATION OF PILANI AND ITS NEIGHBOURHOOD

BY

N. C. NAIR & G. S. NATHAWAT

Department of Botany, Birla College, Pilani, Rajasthan

INTRODUCTION

Pilani in its present phase is a very promising venue for the study of plant succession as the place is undergoing a process of rapid physical developments and changes. An arid sun-scorched sandy area broken by a dreary succession of shifting sand dunes, spotted with trees and scattered and meagre growth of desert plants, is being rapidly converted into the verdure of a cultivated region. The growing plantations of trees such as the large leafy *Ficus*, *Melia*, *Dalbergia*, *Prosopis*, *Albizzia*, *Jacaranda*, *Poinciana*, etc. lining the streets flourish well and impart a green and wooded appearance. The magical transformation is due to the endeavour of the Birla Education Trust.

The earliest attempts to study the vegetation of the place include those of Mulay and Ratnam (1950), and Ramachandra (1950). A synecological study of the vegetation around a temporary pond was made by Ratnam and Joshi (1952). Recently Nair and Joshi (1955) studied the sand dune vegetation of Pilani and its neighbourhood. Bakshi (1954) gave a detailed account of the vegetation of the place covering an area of 40 square miles, and has given a long list of 312 plants. It was found that Bakshi's list requires some correction as it includes a considerable number of plants not found either in the wild or in the cultivated state in the area Bakshi surveyed. He has also omitted a large number of plants and therefore the present paper is called for.

Bakshi has described in detail the ecological features of the vegetation of the area. However, a few words must be said about these aspects to give the reader a general idea of the floristic composition with regard to different habitats.

The rainfall rarely exceeds 15″ and the rainy season is from July to September. The cold season begins towards the close of November and extends up to February. The temperature sometimes falls below freezing point. The spring is of short duration, February and March, and the area blossoms at this period becoming a mass of colour for a short time. From the middle of April to the middle of June the days are very hot and the temperature shoots up to 115° F. Dust storms are also not infrequent in these months.

Bakshi writes, 'as in Jodhpur (Sarup, 1952) there is a constant breeze in Pilani from the south-west to north-east from about February to October with a velocity of nearly 8-10 miles per hour. The velocity increases during May to 20 and the direction changes from west to east'. This is very surprising as there is no anemometer in Pilani or in its close vicinity to determine the speed of the wind.

The nature of the soil varies from locality to locality and based on this three types of localities can be marked out :

(*a*) *Localities with more or less stable dunes.* Vast stretches of sand dunes occur in Pilani. These dunes, though formed of loose sand, are not shifting ones and support a shrubby stunted vegetation especially of *Capparis decidua*, *Gymnosporia montana* and trees like *Prosopis spicigera* and *Balanites roxburghii.* These sand dunes are in a definite direction, generally from south-west to north-east. The soil is calcareous and these dunes put on a green appearance even after very slight showers.

(*b*) *Localities with sand dunes of the moving type.* Like the above area sand is piled up into dunes but they are at the mercy of the winds. The area beyond Vidya Vihar up to the bed of Khantli, a purely rainfed stream, in the west has mostly a rolling topography due to vast stretches of hummocky sand dunes in succession. However, there are indications that the desertic character of the area is fast fading or already lost in some places due to encroaching vegetation. Several spots in this locality, which were full of shifting sand dunes until seven years ago, have been completely colonized by thick growth of *Calligonum polygonoides* and *Saccharum munja.* Sand dunes of the shifting type are also common on either side of Pilani-Loharu and Pilani-Chirawa roads. Sometimes rocky projections raise their heads. The direction of sand dunes in these places depends upon the configuration of such rocky ridges and prominences. The soil is calcareous, as in the above case, and the vegetation in this area is very scanty. Moving dunes in association with rocks are found about two miles north of Pilani town and also near Narh along Pilani-Chirawa road.

(*c*) *Localities with stable sand.* Under this heading come the cultivated fields, the villages, and the Vidya Vihar colony and its neighbouring places. In this area sand has become stable due to prolonged weathering and is different from typical desert soil. The top layer is compact and fertile due to accumulation and admixture of organic matter. It is neutral or slightly alkaline and the pH increases with depth. This is due to increasing proportions of calcium formed due to leaching. This type of soil can grow good crops.

The general character of the vegetation corresponds with the physical aspect, the nature of the soil and irrigation. The Vidya Vihar and its neighbouring areas support a fairly good vegetation. Pure desert until a few years ago, this area at the present time is an extensively green and cultivated tract. Obviously water plays an important role in the development. Water is pumped up from deep wells and is supplied to the various parts of the place. This water supports the luxuriant growth of plants. The Vidya Vihar area is surrounded by cultivated fields interspersed here and there with dunes mostly of the Barchan type. The dominant indigenous trees of the locality are *Prosopis spicigera*, *Tecoma undulata*, *Anogeissus pendula*, *Acacia arabica*, and *Balanites roxburghii.* Wherever sub-soil water is available, agricultural operations are carried on by the villagers.

Beyond the cultivated areas come with incongruous suddenness vast stretches of sandy plain with patches of thick growth here and there. The grayness of the area is increased by spiny and thorny plants. The vegetation is a scrub jungle composed mainly of the more dominant species *Prosopis spicigera* and *Capparis decidua*, and wherever thick growth occurs it is mainly a *Prosopis-Capparis* association. The common plants of the locality are *Tecoma undulata*, *Anogeissus pendula*, *Salvadora oleoides*, *Balanites roxburghii*, *Acacia arabica*, *Mimosa hamata*, *Zizyphus rugosa*, *Gymnosporia montana*, *Calotropis procera*, *Leptadenia spartium*, *Ephedra foliata*, *Clerodendrum phlomidis*, *Lycium europaeum* etc. In summer the ground lies bare except for a few hardy perennials and the area puts on a turf of greenery after the rains. The ground vegetation just after the rains consists mainly of *Tephrosia purpurea*, *Trianthema* sp., *Tribulus terrestris*, *Aerua tomentosa*, *Phyllanthus madraspatensis*, *Phyllanthus niruri*, *Achyranthes aspera*, *Cleome viscosa*, *Polygala erioptera*, *Polygala abyssinica*, *Mollugo* sp., *Crotalaria burhia*, *Corchorus acutangulus*, *Boerhavia diffusa*, and grasses mainly *Eragrostis* sp., *Cenchrus* sp., *Andropogon* sp., *Cyperus rotundus*, etc. In subsequent months the vegetation is rather scanty, as most of the above-mentioned plants dry up. In winter only a few plants, such as *Argemone mexicana*, *Achyranthes aspera*, *Heliotropium* sp., *Trichodesma indicum*, *Coronopus didyma*, *Launea* sp. etc., are found.

In loose rippled sand *Calotropis procera*, *Crotalaria burhia*, *Aerua tomentosa*, *Panicum turgidum*, *Cenchrus biflorus*, *Citrullus colocynthis*, *Mollugo* sp., *Eragrostis* sp., etc., are the early colonizers. The stabilized dunes show an interesting elevational zonation, and this aspect was dealt with in some detail by Nair and Joshi (1955).

The vegetation in the rocky areas is very sparse. In the crevices and other places where some soil has been formed grow *Orygia decumbens*, *Cnicus wallichi*, *Clerodendrum phlomidis*, *Pupalia lappacea*, *Stachytarpheta indica* and grasses such as *Conchrus*, *Eragrostis*, *Andropogon*, etc. The common tree species in these rocky areas is *Acacia senegal*.

ADDITIONS TO BAKSHI'S LIST

NYMPHAEACEAE

Nymphaea stellata Willd. Cultivated in gardens.

MENISPERMACEAE

Cocculus cebatha DC. A woody climber. Common ; flowers after rainy season.

CRUCIFERAE

Farsetia hamiltonii Royle. Rare ; flowers, July–Sept.

Sisymbrium irio Linn. A medium-sized hairy annual with pinnately divided leaves, end lobes large, but often arrow-headed, flowers yellow, capsules 1½–2½″ long.

Cheiranthus cherii Linn. Cultivated in gardens.

CAPPARIDACEAE

Cleome papillosa Steud. A strongly scented, hairy, glandular annual ; leaves cordate, penninerved, lower long-stalked, upper sessile or nearly so ; flowers very small, pinkish to dirty yellow, in racemes ; seeds reniform. Common after the rains.

POLYGALACEAE

Polygala abyssinica Bresch. Common.

CARYOPHYLLACEAE

Spergula rubra Linn. A green annual of moist places. Leaves opposite; seeds wingless; flowers cold season.

PORTULACACEAE

Portulaca grandiflora Linn. Cultivated in gardens. Flowers red, opening at noon.

TAMARICACEAE

Tamarix dioica Roxb. A small tree with drooping branches. Flowers pinkish in peduncled and panicled spikes. Disc of flower 5-lobed, anthers purple.

MALVACEAE

Bombax malabaricum DC. Cultivated. A few plants in Vidya Peeth garden.

Hibiscus micranthus Linn. A small shrub; flowers axillary, single, pink or white. Seeds cottony. Rare in rocky areas.

Thespesia populnea Corr. Three plants have been introduced in the nursery in 1955.

Sida grewioides Guill. Common in dry places. Flowers white or yellow. Corolla slightly exceeding the calyx.

STERCULIACEAE

Guazuma tomentosa Kunth. A few plants cultivated.

TILIACEAE

Grewia oppositifolia Roxb. A small under-sized tree. Leaves large (2–4 by 1–2·5″) with stout petioles. Peduncles leaf-opposed or few axillary. Fruit one- to 4-lobed, black when ripe. Often cultivated by the villagers for the fruits. Leaves lopped for fodder. The bast fibre is used for ropes. The wood has an unpleasant smell when burnt. Flowering from April to August.

Triumfetta pilosa Roth. Herbaceous or shrubby; lower leaves ovate, upper lanceolate, all stellately hairy; flowers yellow in fascicled leaf-opposed cymes. Spines of fruit hooked. Rare; flowers during cold season.

Corchorus antichorus Raeusch. A small woody perennial. In dry places; capsule straight or curved, cylindric, beaked, four-valved. Common. Used as fodder for camels. Flowers Sept.–Oct.

Corchorus urticaefolius W. and A. Capsules short, slightly three-angled, bent downwards, valves with transverse partition. Leaves cordate or ovate, acuminate. Common; flowers rainy season.

ZYGOPHYLLACEAE

Tribulus alatus Delile. Leaflets five pairs or less. Common during rainy season.

Fagonia bruguieri DC. Branches trigonus, grooved ; leaflets ovate, fleshy. Internodes very short. Leaves three-foliate in the lower, one-foliate in the upper parts.

RUTACEAE

Feronia elephantum Correa. Cultivated in the Botanical garden.

Citrus medica Linn. The following varieties are cultivated.
var. *medica.*
var. *limonium.*
var. *acida.*
var. *limetta.*

Aegle marmelos Corr. Cultivated particularly near temples. Flowers April and May. The fruit ripens a year later.

LEGUMINOSAE

Crotalaria juncea Linn. Cultivated ; rare.

Indigofera linifolia Retz. Flowers during the rainy and cold seasons.

Indigofera subulata Vahl. Common during the rainy season.

Indigofera trigonelloides J. & S. Rainy season, frequent.

Trigonella foenum-graecum Linn. Common during the rainy season.

Alysicarpus tetragonolobus Edgew. Rainy season.

Vicia hirsuta Koch. Rare. A wiry herb. Flowers cold season and after.

Dolichos biflorus Linn. Cultivated.

Erythrina suberosa Roxb. Cultivated in gardens.

Phaseolus pauciflorus. Cultivated.

Phaseolus semierectus Linn. A few plants from the farm area in Sept. 1955. Most probably introduced along with other seeds.

Caesalpinia pulcherrima Linn. Cultivated.

Cassia siamea Lamk. Planted along roadsides and also in gardens. Introduced in 1949.

Cassia tora Linn. A small shrub. Rare ; flowers during rainy season.

Cassia obovata. Rare ; flowers during rainy season.

Poinciana regia. Planted on roadsides. Frequent. Flowers Feb.–March.

Acacia jacquemontii Benth. A thorny bush with sweet-scented yellow flowers in globose heads. Bark used for tanning. Branches lopped for fodder. Flowers Feb.–May. Rare.

Acacia leucophloea Willd. A small tree. Easily recognised by its terminal panicles of flowers and brown velvety pods. Flowers Aug.–Nov.

Mimosa rubicaulis Lamk. A shrub with smaller prickles (0·1″ long) than *Mimosa hamata.* Flowers pink turning to white, in globose spikes in axillary fascicles. Fruit flat square. Sutures slightly prickly. Flowers July to Sept. Rare. (Gamble considers the North Indian plant clearly distinct from Lamarck's species and calls it *Mimosa himalayensis* Gamble. (*Vide* Kew. Bull. 1920, p. 6.)

COMBRETACEAE

Quisqualis indica Linn. Cultivated in gardens.

CUCURBITACEAE

Momordica balsamina Linn. Bracts variegated. Common during the rainy season.

Bryonia laciniosa Linn. A few plants were seen in August 1954 in the farm area.

Cucumis trigonus Roxb. A trailing herb. Stems with rigid hairs. Leaves 3–5-lobed, roughly circular in outline, covered with hairs on both surfaces. Male flowers in small clusters. Female flowers standing single. Fruit small, yellow when ripe. Flowers August–November.

Cucurbita moschata Dusch. Cultivated.

Ctenolepis cerasiformis Naud. A monoecious climber. The stipuliform bract is the characteristic feature of the species. The only other report about this plant from Rajasthan is from Harsh Nath by Nair and Nathawat (1956).

FICOIDEAE

Mollugo spergula Linn. Very rare. Just after the rains.

Trianthema hydaspica Edgew. Very rare. Flowers after the rainy season.

Orygia decumbens Forsk. In rocky places. Frequent. Flowers July–October.

RUBIACEAE

Spermacoce stricta Linn. Erect herb ; both carpels dehiscing ventrally. Seeds polished.

Oldenlandia corymbosa Linn. Common after the rainy season.

Oldenlandia brachiata Hook. An annual ; stem four-angled. Rare. Sept.–Nov.

COMPOSITAE

Dicoma tomentosa Cass. A densely white tomentose herb. Heads solitary, subaxillary and terminal. Rare.

Pulicaria wightiana Clark. Common. Flowers Oct.–Jan.

Launea pinnatifida Cass. Common during the cold season.

Cnicus wallichii DC. Robust shrub with spreading branches. Leaves sessile, pinnatifid, tomentose, lobes ending in long slender, rigid spine; rare; flowers in cold season.

Sonchus asper Hill. Rare, cold season.

Echinops echinatus DC.

SAPOTACEAE

Achras sapota Linn. (*A. zapota* Linn). An evergreen tree, cultivated in most places. Flowers appear throughout the year, the fruits ripen mainly during March, April, August and September.

Mimusops hexandra Roxb. A handsome tree. Flowers Nov.–Dec. Calyx lobes 6, stamens 6, alternating with 6 staminodes. Ovary 12-celled. Cultivated.

APOCYNACEAE

Lochnera pusilla K. Schun. A small annual with white flowers; common in the fields as a weed.

Ervatamia coronaria Stapf.—*E. divaricata* (Linn.) Alston. (Syn. *Tabernaemontana coronaria* R. Br.) A small shrub of gardens. Flowers white, fragrant at night, inodorous during day. Follicles with 3–6 seeds embedded in a red fleshy aril.

Ervatamia dichotoma Blatter. A small shrub. Only two plants in Chandra Bhavan.

Wrightia tomentosa Roem. A rare deciduous tree. Young parts tomentose; corona of orange-coloured scales. Follicles black, 8–14″ long, laterally compressed. Flowers rainy season.

Plumeria acutifolia Poiret. Cultivated in gardens. Flowers white. Fragrant.

Allamanda cathartica Linn. A woody climber with large bright yellow flowers. Cultivated.

ASCLEPIADACEAE

Ceropegia tuberosa Roxb. A perennial herb. Rare. Flowers during rainy season.

Cryptostegia grandiflora R. Br. A large evergreen ornamental woody climber with rose flowers. Cultivated.

Asclepias curassavica Linn. A Mexican plant, common in gardens.

BORAGINACEAE

Heliotropium indicum Linn. Leaves up to 4″ long. Fruit beaked; common in moist places. Flowers Oct.

Heliotropium subulatum Hochst. Spikes not bracteate. Fruit not beaked; nutlets rounded tuberculated on the back. Flowers cold season.

Heliotropium ovalifolium Forsk. Spikes with persistent bracts, fruit not beaked. Nutlets densely silky on the back. Flowers cold season.

Heliotropium marifolium Retz. Spikes bracteate, bracts conspicuous, leaf-like, lanceolate. Fruit bristly, subglobose, nutlets brown.

Arnebia hispidissima DC. A diffuse hairy herb. Flowers small, white in racemes. Nutlets tuberculated on all sides. Common. Flowers hot season.

Sericostoma pauciflorum Stocks. A straggling undershrub of sandy soil. Flowers Dec.–Feb.

CONVOLVULACEAE

Cuscuta reflexa Roxb. Parasite on small trees or shrubs. Flowers Sept.–Feb. Rare.

Merremia pentaphylla Hallier. Cultivated.

Ipomea quamoclit Linn. Rare, in gardens.

SOLANACEAE

Lycium europeum Linn. A thorny shrub. Flowers white, Oct.–March. Common in sandy areas.

Cestrum nocturnum Linn. Cultivated in gardens for the fragrant flowers.

SCROPHULARIACEAE

Anticharis linearis Hochst. (*Doratanthera linearis* Benth). A Small herb with purple flowers. Common, August–December.

Russelia juncea Zucc. A Mexican shrub with rush-like green and ribbed stems, branches slender in whorls. Common in gardens. Flowers most part of the year.

Linaria minor Desk. Cultivated in gardens.

BIGNONIACEAE

Tecoma stans Juss. (*Stenolobium stans* Seem) A large shrub; leaves pinnate; flowers yellow, corolla with red lines on the inside. Cultivated in gardens and also as a hedge plant; common. Flowers Sept.–April.

Tecoma capensis Lindl. (Syn. *Tecomaria capensis* Spach). A rambling shrub indigenous to south Africa. A few plants cultivated in gardens.

Millingtonia hortensis Linn. Indian cork tree. A tall tree with white fragrant flowers in panicles. Believed to be indigenous to Burma. Common in gardens; spreads naturally by root suckers. Flowers March–April.

Kigelia pinnata DC. Sausage tree. A medium-sized tree, indigenous to tropical Africa. Commonly cultivated on the sides of roads.

Jacaranda mimosaefolia D. Don. (Syn. *J. ovalifolia* R. Br.). A handsome tree with beautiful blue flowers in terminal panicles. Flowers April. In gardens.

PEDALIACEAE

Pedalium murex Linn. In sandy places; rare.

ACANTHACEAE

Blepharis scindica T. Anders. A spinous bristly small shrub with flowers in strobilate spikes. Flowers Sept.–Oct. Rare, in sandy areas. As far as we are aware, this is the first report of the plant from Rajasthan.

Peristrophe bicalyculata Nees. An erect herb. Stem six-angled. Flowers in trichotomous cymose panicles. Flowers pink; Oct.–Jan.

Thunbergia sp. Cultivated in gardens.

VERBENACEAE

Vitex negundo Linn. A hedge plant; rare.

Clerodendrum inerme Gaertn. An evergreen unarmed shrub. Grown in gardens. Flowers white.

LABIATAE

Ocimum basilicum Linn. Cultivated.

Ocimun canum Sim. Rare.

Leucas urticaefolia R. Br. Common.

PLANTAGINACEAE

Plantago amplexicaulis Cav. A sparsely hairy annual with a short branching stem; leaves sheathing, radical, narrowly lanceolate; many axillary scapes exceeding the leaves and ovate spikes. Sepals four with thick green midrib and membranous margins. Corolla white, lobes concave. Capsule two-seeded. Seeds boat shaped fused with the pericarp. Common in stabilised soil during cold months. This is the first report of the plant from Rajasthan.

AMARANTACEAE

Nothosaerua brachiata Wt. An erect slender branching herb; stems sparsely hairy; leaves elliptic-lanceolate, narrowed at the base, Spikes cylindrical. Perianth 3–5-lobed; stamens 2, free; ovule single; flowers October to December. Borders of fields and moist places.

Aerva lanata Juss. Rare. Flowers rainy season.

Alternanthera bicolor In gardens. Rare.

Celosia argentea Linn. Cultivated in gardens. Often found as an escape but never wild.

CHENOPODIACEAE

Chenopodium glaucum Linn. Common, January–April.

Atriplex crassifolia C.A. May. Frequent cold season.

POLYGONACEAE

Rumex dentatus Linn. The enlarged perianth in fruit with a smooth tubercle on the back, and margins irregularly toothed. Common in winter.

Antigonon leptopus Hook. Coral creeper. Cultivated in gardens. Flowers July–November.

Muehlenbeckia platyclados Meiss. A glabrous shrub indigenous to Solomon Islands. Recently introduced in the Botanical garden.

EUPHORBIACEAE

Euphorbia dracunculoides Lamk. A dichotomously branched slender annual, 10–20″ high with sessile, linear or linear-lanceolate leaves, lower alternate, upper opposite. Floral leaves shorter ; involucre subsessile, solitary in between the branches, campanulate hairy on the inside, lobes ovate ciliate ; glands crescent-shaped ; styles free to the base, bifid ; testa of seed brownish white leprous. Caruncle small. This plant was first noticed in Pilani in Feb. 1954, near the Engineering College. In the years that followed it was noticed at several spots, during the months of January–March.

Euphorbia millii Ch. des Moulins (Syn. *E. splendens* Bojer) Cyathium is closely subtended by two broadly ovate bright red bracts. Cultivated as a pot plant, very rare.

Phyllanthus emblica Linn. Only very few plants. Cultivated.

Fluggea leucopyrus Willd. A rigid bushy shrub, branches terminating in sharp thorns. Frequent. Flowers July–August.

Crozophora obliqua A. Juss. A herb; leaves stellately tomentose on both sides. Stamens five, ovary covered with stellate hairs and scales. Rare.

Croton sparsiflorus Morung. A low shrub ; Leaves ovate to lanceolate, serrate at apex ; leaf stalk has a pair of bracts (?) at the base. Flowers in slender racemes at the ends of branches ; male flowers at the upper region, female flowers very few, stamens 10–15, outer perianth green, inner white (absent in female flowers). Capsule hairy, three-angled ; seeds shining, spongy white, cap conspicuous. Flowers most part of the year. A native of S. America. Introduced in

Bengal in 1898 or so, after which it has spread rapidly throughout India. However, this is the first report of the plant from Rajasthan. In Pilani the plant was first noticed by the authors in 1953. Now colonies of it occur at various places in the area.

Poinsettia pulcherrima Grah. A few plants cultivated in gardens.

Bridelia stipularis Blume. A scandent shrub with dark grey bark. Flowers monoecious, greenish yellow, in axillary clusters. Male flowers sessile. Female pedicelled. Rare. This appears to be the first record of this plant from Rajasthan.

Breynia rhamnoides Muell. An evergreen shrub; leaves distichous, alternate; stipules short setaceous. Flowers monoecious in few-flowered, axillary clusters. Male flowers : calyx with six inflexed teeth, stamens three, pistillode absent. Female flowers : Calyx campanulate, six-lobed, enlarged in fruit. Rare.

URTICACEAE

Ficus glomerata Roxb. Cultivated. Rare. Fruit edible.

SCITAMINACEAE

Musa sapientum Linn. Rare, cultivated.

AMARYLLIDACEAE

Crinum asiaticum Linn. Cultivated in gardens; common.

Crinum latifolium Linn. Common in gardens.

LILIACEAE

Aloe vera Tourn. In gardens.

Ruscus hypophyllum Linn. A small shrub 12–18″ high. Leaves replaced by phylloclades. Cultivated in gardens.

Sanseviera cylindrica. In gardens, not rare.

Yucca sp. In gardens, rare.

Dracaena angustifolia Roxb. Cultivated in gardens.

PALMAE

Phoenix dactylifera. Only very few plants. Cultivated.

PANDANACEAE

Pandanus sp. A few plants cultivated around Shivganga. Introduced in 1953.

COMMELINACEAE

Tradescantia sp. Very rare. Cultivated.

GRAMINEAE

Cenchrus ciliaris Linn.

Cenchrus prieri (Kunth) Maire

Saccharum munja Roxb. A tufted perennial grass spreading rapidly by suckers. A good fibre is obtained from the plant. Common.

Saccharum spontaneum Rare, cultivated.

Melanocenchris royleana Nees. (*Gracilea royaleana* K K. f).

Cymbopogon parkeri Stapf.

Sporobolus orientalis Kunth.

Sporobolus glaucifolius Hochst.

Sporobolus virginicus Kunth.

Poa aspera Jacq.

Setaria glauca Beauv.

Setaria verticillata Beauv.

Tragus biflorus Schut.

Dactyloctenium scindicum Boiss. (*Eleusine scindica* Duthie).

Dichanthium caricosum A. Camus.

Brachiaria ramosa Stapf (*Panicum ramosum* Linn.).

Brachiaria paspaloides Presl.

Digitaria adscendens (H.B.K.) Henr. (*Panicum adscendens* H.B.K.).

Digitaria sanguinalis Scop. (*Paspalum sanguinale* Linn.).

Digitaria longiflora.

Aristida funiculata Trin. & Rup.

Aristida depressa Retz. (*Aristida adscensionis* Linn.).

Desmostachya bipinnata Stapf. (*Eragrostis cynosuroides* Beauv.)

Eleusine verticillata Roxb.

Echinochloa colonum Link. (*Panicum colonum* Linn.).

Echinochloa stagnina Beauv. (*Panicum stagninum* Retz.).

Eragrostis viscosa Trin.

Eragrostis gangetica Steud.

Eragrostis plumosa Link.

Eragrostis minor Host.

Sorghum halepense (L.) Pers.

Bambusa arundinacea Willd. Cultivated in Chandra Bhavan.

CYCADACEAE

Cycas revoluta Beddome. Cultivated in gardens.

CORRECTIONS, AND LIST OF PLANTS REPORTED BY BAKSHI BUT NOT FOUND IN THE AREA SURVEYED BY HIM

CAPPARIDACEAE

Crataeva religiosa Forst.

VIOLACEAE

Viola cinerea Boiss.

CARYOPHYLLACEAE

Saponaria vaccaria Linn. Bakshi states that it is a frequent weed in the fields. But we have seen it only in the cultivated state in gardens, and it never runs wild in Pilani.

ELATINACEAE

Bergia odorata Edgw.

MALVACEAE

Sida veronicaefolia Lamk.

STERCULIACEAE

Waltheria indica Linn.

GERANIACEAE

Monsonia senegalensis Guill. & Perr.

LEGUMINOSAE

Alhagi camelorum Fisch. Strangely enough Bakshi mentions it to be a common species. Not only in Pilani but also in the neighbouring places the existence of this plant is doubtful (See Nair, 1955 ; Nair and Nathawat, 1956). It is a plant characteristic of western Rajasthan.

Butea monosperma. Bakshi considers it to be a common tree in Pilani. There is only a single tree in the whole of the area surveyed by Bakshi and it was introduced into the Botanical garden in 1953.

Tamarindus indica Linn. Bakshi states that it is a frequent plant of the locality. There are only half a dozen plants (cultivated) in the area surveyed by him.

Acacia modesta Wall.

COMBRETACEAE

Terminalia arjuna Bedd. Five plants are cultivated around Shiv Gana, but Bakshi reports it to be a frequent species of the locality.

CONVOLVULACEAE

Rivea ornata

SCROPHULARIACEAE

Antirrhinum orontium Linn.

PEDALIACEAE

Martynia diandra Gl.

ACANTHACEAE

Adhatoda vasica Nees (*Justicia adhatoda* Linn.). Bakshi mentions that this plant is not infrequent in Pilani, but we have not come across it anywhere in the area surveyed by him. Several attempts have been made to grow this plant in the Botanical garden and elsewhere but failed.

VERBENACEAE

Lantana indica Roxb. Bakshi writes that this plant is frequent in Pilani becoming a troublesome weed in some places. His statement is erroneous as this plant does not occur at all in the wild state. It was in 1953 that a few plants were introduced in one of the gardens and they too do not grow well.

Stachytarpheta indica Vahl. Bakshi mentions about blue flowered plants. We have observed only white flowered plants, and the existence of blue flowered plants is not likely.

LABIATAE

Salvia aegyptiaca

Leonotis nepetaefolia

CHENOPODIACEAE

Kochia indica Wight.

EUPHORBIACEAE

Euphorbia royleana Boiss.

Euphorbia neriifolia Linn.

CONCLUSION AND SUMMARY

The aim of the present paper is to correct Bakshi's account of the vegetation of Pilani and its neighbourhood, and to provide some more information with regard to the vegetation of the locality. 145 new plants have been recorded. A list of plants not found either in the wild or in the cultivated state, but reported by Bakshi, is given.

Excluding known cultivated plants, the flora of Pilani and its neighbouring villages consists of 275 species representing 165 genera and 51 families. Gramineae is the only Monocotyledon well represented, There are 60 species of monocotyledonous plants of which Gramineae consists of 49 species. Except Leguminosae and Compositae the Dicotyledons are also poorly represented. Of the 215 species of Dicotyledons 34 belong to Leguminosae, 18 belong to Compositae, while the remaining 163 species belong to 44 families. There is only a single Gymnosperm *Ephedra foliata.*

The ratio of Monocotyledons to Dicotyledons is 1 : 11·5 of families, 1 : 4·3 of genera, and 1 : 3·8 of species. The ratio of genera to species is 1 : 1·64.

23 families have 1 genus each, and of the remaining 28 families 11 have 2 genera, 2 have 3 genera, 4 have 4, 6 have 5, 1 each has 6, 7, 15, 16, and 24 genera respectively. The families having 6 or more genera are Amarantaceae, Euphorbiaceae, Leguminosae, Compositae, and Gramineae. Of the 165 genera, 101 are represented by a single species, 32 by 2 species, 14 by 3, 3 by 4, 6 by 5, and 2 by 6. The families having 6 or more species are Cruciferae (6), Capparidaceae (6), Cucurbitaceae (6), Asclepiadaceae (6), Solanaceae (6), Tiliaceae (8), Convolvulaceae (8), Acanthaceae (8), Amarantaceae (8), Boraginaceae (9), Malvaceae (11), Euphorbiaceae (12), Compositae (18), Leguminosae (34), and Gramineae (49). These families make more than three-fifths of the flora. The various genera are poorly represented. The largest genera containing 4 or more species are *Mollugo* (4), *Trianthema* (4), *Cenchrus* (4), *Sida* (5), *Corchorus* (5), *Indigofera* (5), *Tephrosia* (5), *Acacia* (5), *Euphorbia* (5), *Eragrostis* (6), and *Heliotropium* (6).

Out of 275 species 21 are trees, 49 are shrubs or undershrubs and 205 herbs. Phanerogamic hydrophytes are not represented in the natural vegetation of the area under consideration. *Cuscuta*, *Striga*, and *Cistanche* are the parasitic genera of phanerogams. Climbing plants are well represented. 32 species of climbers belonging to 12 families are present in the flora of the area. The largest numbers of climbers belong to Convolvulaceae, Cucurbitaceae, and Leguminosae.

The psamophytes of the locality are *Farsetia jaquemontii*, *F. hamiltonii*, *Polygala erioptera*, *P. abyssinica*, *Polycarpaea corymbosa*, *Tribulus terrestris*, *Fagonia* sp., *Corchorus antichorus*, *Zizyphus rugosa*, *Z. xyloporus*, *Crotalaria burhia*, *Indigofera argentea*, *I. cordifolia*, *Tephrosia* sp., *Cassia toara*, *Citrullus colocynthis*, *Mollugo* sp., *Gisekia pharnaceoides*, *Spermacoce* sp., *Oldenlandia* sp., *Pulicaria wightiana*, *Echinops echinatus*, *Launea* sp., *Pluchea lanceolata*, *Calotropis procera*, *Leptadenia spartium*, *Lycium europeum*, *Pedalium murex*, *Boerhavia diffusa*, *Aerua tomentosa* *Calligonum polygonoides*, *Cyperus arenarius*, *Cenchrus* sp., *Saccharum munja*, *Digitaria marginata*, *Panicum turgidum*. *Aristida depressa*, *Eragrostis* sp., *Sporobolus* sp., *Setaria* sp., and *Andropogon annulatus.*

The data presented in the previous pages suggest that there is a close similarity between the flora of Pilani and its neighbourhood and that of Chirawa (Nair, 1956). The dominant families and genera of western Rajputana and the area under consideration are practically the same (see Blatter and Hallberg, 1918–1921 ; Sarup, 1951 : Sankhala, 1951 : Sabnis, 1929). However, the absence of some of the very characteristic plants of western Rajasthan, e.g., *Alhagi camelorum*, *Euphorbia royleana*, *E. neriifolia*, *E. jodhpurensis*, *E. nivulia* etc. is very striking.

We are thankful to Dr. B. N. Mulay for facilities and encouragement. We are also thankful to Messrs. M. C. Joshi and B. D. Deshpande for their interest and helpful suggestions.

BIBLIOGRAPHY

Bakshi, T. S. (1954) : Vegetation of Pilani and its neighbourhood, *JBNHS*, **52** : 484–514.

Blatter, E. & Hallberg, F. E. (1918–1921), The flora of the Indian desert. ibid. **26–27** (different pages).

Hooker, J. D. (1885) Flora of British India, London.

Mulay, B. N. & B. V. Ratnam (1950) : Study of vegetation found round about Pilani and its neighbourhood. *Proc. Indian Sci. Cong.* Poona (3) : 64–65.

Nair, N. C. (1956) : Flora of Chirawa. *Proc. Raj. Acad. Sci.* **6** : 49–64.

Nair, N. C. & Joshi, M. C. (1955) : Sand dune vegetation of Pilani and its neighbourhood. *Symp. Vegetation types India.* Baroda. (unpublished).

Nair, N. C. & Nathawat, G. S., Vegetation of Harshnath. *JBNHS* (in press).

Ramachandra, K. R. (1950): Common grasses found round about Pilani. *Proc. Indian Sci. Cong.* Poona. (3) : 65–66.

Ratnam, B. V. & Joshi, M. C. (1952): An ecological study of the vegetation near about a temporary pond in Pilani. *Proc. Raj. Acad. Sci.* **3** : 1–15.

Sabnis, T. S. (1929): A note on the ecology of the flora of Sind. *J. Indian Bot. Soc.* **8** : 263-236.

Sankhala, K. S. (1951): Enumeration of the flowering plants of North-western Rajasthan. *Uni. Rajputana studies. Biol. Sect.* **1** : 43–56.

Sarup, S. (1951) : A list of common plants of Jodhpur and its neighbourhood. ibid. **1** : 29–35.

DIFFERENTIAL RESPONSE TO FORM AND PATTERN IN TWO SPECIES OF INDIAN HONEYBEES[1]

BY

K. K. DIXIT, M.SC.

(Department of Zoology, University of Poona)

(With two text figures)

CONTENTS

	PAGE
1. INTRODUCTION	107
2. MATERIALS	109
3. METHOD OF EXPERIMENTS	110
4. OBSERVATIONS	112
5. DISCUSSION	114
6. SUMMARY	116
7. ACKNOWLEDGEMENTS	117
REFERENCES	117

I. INTRODUCTION

Honeybees are the most important among the social Hymenoptera as agents for pollination in plants. This is mainly due to their faculty of flower constancy, by which is meant the attachment of honeybees to flowers of a particular species of plant for obtaining nectar and pollen for a considerable period of time. In returning to the same type of flower and in being able to distinguish between flowers of different species of plants, the honeybees are supposed to make use of certain clues, such as the colour, form, scent, and the position of the flowers. However, it is only in the European honeybee *Apis mellifera* that these factors of sensory physiology and behaviour have been analysed and have been proved to be of importance in the phenomenon of flower constancy. It was with the object of investigating the possible importance of 'form' in the flower constancy shown by Indian honeybees that the present work was undertaken.

Considerable work on the problem of discrimination of form and pattern in *A. mellifera* based both on spontaneous preference and on preference induced by training has been done in Europe, especially by German workers.

Von Frisch (1914) trained honeybees to select a sunflower-shaped pattern from a gentian-shaped one, but neither he nor Hertz (1929a) could succeed in training the bees to distinguish between such figures as triangles, squares, and circles. However, the bees could distinguish these patterns from the subdivided ones, and they could easily be trained to choose only the more subdivided pattern. Hertz (1929b) also performed experiments on the spontaneous, as opposed to induced, form-preference in *A. mellifera*. She did these by training bees to feed from a uniform white surface and then offering them a choice of two alternative black-on-white patterns on which they had never been fed. They preferred any black figure to the white background and so Hertz came to the conclusion that their spontaneous preference regarding various figures was related to the quantity of outline, irregularity and size of patterns, and the independence of their components. There was no absolute criterion of attractiveness, but the attractiveness of any pattern depended upon its value relative to that of other objects which the bee could see at that time. At any rate, bees preferred the most contrasting patterns. Later, Hertz also performed experiments with three dimensional models. The result was that bees responded to the shadows of these three dimensional models in the same way as they did to the black parts in the black-on-white patterns.

---

[1] Dedicated to Prof. K. von Frisch on his seventieth birthday.

Gertrud Zerrahn (1933), who trained honeybees to one pattern and then presented them with a choice of two patterns which were similar in character but different in their degree of subdivision, also concluded that the bees had a spontaneous tendency to alight upon whatever pattern possessed the greatest length of contour. Wolf and Zerrahn-Wolf (1935) offered untrained honeybees a free choice of pairs of chessboard patterns and they concluded that the reaction of bees to patterns depended only on the rate of change in the stimulation of their eyes. Wolf (1933 a, b) demonstrated the importance of 'flicker' in bee vision, and concluded that the quick variation in the stimulation of the facets would cause the bee to alight, and discover groups of flowers.

This simple hypothesis, however, can not explain all the observed facts. After taking a review of all the work done on this subject, including her own work, Hertz (1935) concluded that the amount of outline possessed by different black-on-white patterns was certainly not the only quality by which they were distinguished; a figure was perceived as a complex thing, which might have several different properties which could be used for alternative training.

From the foregoing, it appears that our knowledge of the subject of form discrimination in honeybees is far from complete. The conclusions reached by Hertz, Wolf, and Zerrahn are partially contradictory. Ribband's book (1953) contains a wealth of information on the vision of honeybees and yet his section on 'Perception of Form and Pattern' leaves the impression that much more data are necessary. There is, however, a certain measure of agreement on one point, namely that, when the bees are confronted with a pair of figures of similar general character (but differing in the amount of contour or degree of subdivision), they prefer the figure with greater contour to the one with less, as long as they are able optically to resolve both patterns and consequently recognise them as such.

In attempting to investigate the response of the Indian honeybees to form and pattern, the following problems were posed:

(i) What preferences, if any, do the various species of Indian honeybees show for one of two patterns similar in all respects except in their length of contour (or degree of subdivision, contrast, degree of brokenness, etc.)?

(ii) If there is such a preference, is there a point of subdivision of pattern at which this preference is reversed? And if so, when?

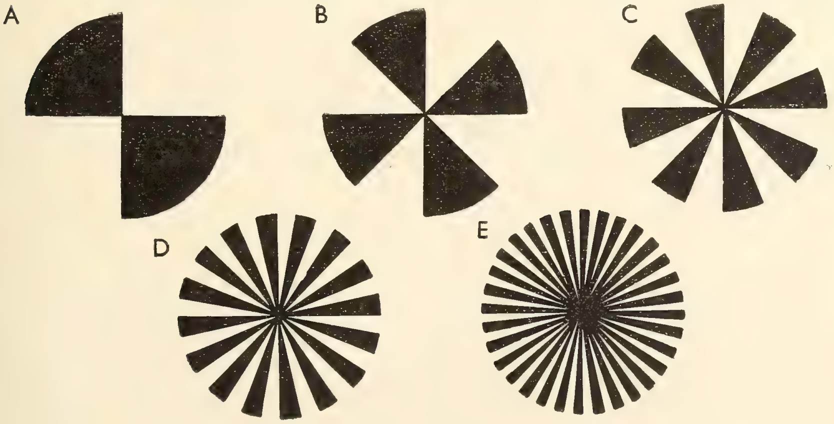
(iii) Does the choice of pattern depend on the distance at which the bee decides on which of the two to alight?

2. MATERIALS

Results recorded in this paper have been obtained from experiments on *Apis indica* and *Apis florea*. During the training of the bees and the tests, the experimental table was covered with a uniform light grey paper. During the test this background of light grey served to provide a strong contrast to all other patterns provided which were made in jet black.

Two series of patterns (or figures) similar to some used by Zerrahn (1933), one later referred to as the star series, and the other the chequerboard (or chessboard) series, have been used in these experiments. In the star series of patterns, photographic black paper was cut and stuck on light grey (same as the background colour) cardboard discs.

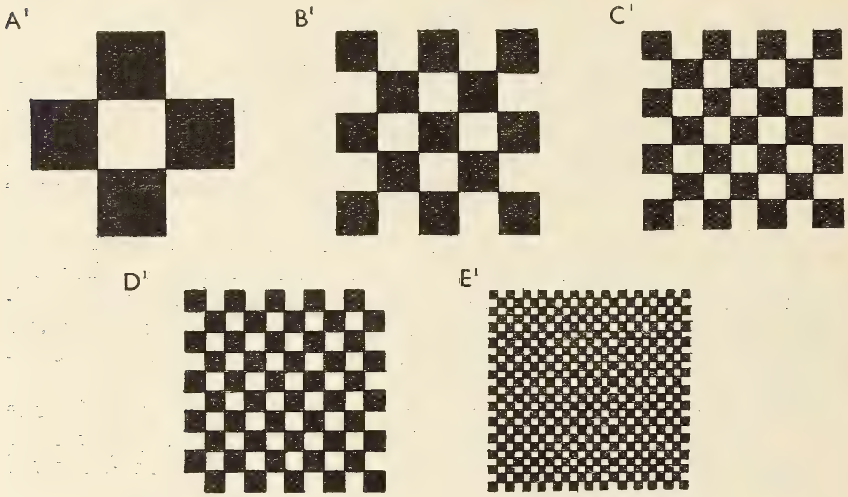
The radius of each pattern was always the same, namely one inch. The star series consisted of five gradations of patterns of increasing complexity shown in text figure 1 (A-E). Pattern A showed the least amount of contour between black and light grey. The amount of contour increases successively through B, C and D to reach its climax in E. Two specimens of each grade of pattern were prepared. In addition to these patterns, two specimens each of solid black discs and solid medium grey discs of the same diameter as the black rays



TEXT-FIGURE 1. Star series of patterns A to E.

in the star series were prepared. The medium grey chosen (M 15 of the standardized Baumann series) was approximately intermediate in shade between the light grey and the black used in these experiments.

In the chessboard series two figures each of five grades of patterns of increasing contour complexity were prepared. Here, however, the black parts of the figure were not stuck on light grey squares but were painted jet black in Indian ink on it. The five grades in the chessboard series are designated as A′, B′, C′, D′, and E′ (figure 2). The least subdivided pattern A′ presents the least amount of contour of black and light grey, while the degree of subdivision as well as the amount of contour increases successively through B′, C′ and D′ to reach its climax in E′. Two specimens of medium grey squares (M 15) were also prepared for the chequerboard series.



Text-figure 2. Chequerboard series of patterns A′ to E′

3. Method of Experiments

At the beginning of the experiments with each of the two species of honeybees the bees had first to be lured to the experimental table in order to perform the experiments. The method of luring both *A. indica* and *A. florea* is essentially the same. The bees are lured either directly from the hive when it is accessible, or else from the flowers on which they feed in nature. During luring a piece of filter paper smeared with honey is held near the bees. When one of the bees happens to crawl on this honey-soaked filter paper it feeds from it. After feeding, the bee returns to the hive and apparently alerts its companions, for in a short while a group of about ten to fifteen bees is seen feeding from the filter paper. The filter paper together with the bees thereon, is then slowly transferred, by stages, to the experimental table where concentrated sugarwater drops are uniformly scattered over a transparent piece of 'Perspex' (I.C.I.) which, in its turn lies above the light grey paper which forms the background colour. The filter paper together with the bees on it is finally kept near one of these sugarwater drops. When the honey on the filter paper is exhausted, bees discover the sugarwater drops and commence feeding on them. The filter paper is then discarded. Thereafter, the bees regularly visit the experimental table and feed on sugarwater drops. The sugarwater drops are renewed as soon as they are exhausted. This part of the experiment is called the training. The bees in this case are being trained to associate food with the light grey colour of the uniform background. If the bees have been fed for a sufficiently long time on a given spot, they automatically visit the same spot at approximately the same hour on subsequent days. This fact obviates the need of luring the bees to the experimental table every day.

The perspex, referred to above, is of the same appearance as glass but differs from it inasmuch as it does not cut away the ultra-violet rays to the same extent. During the training of the bees as well as the tests, a piece of perspex covers the whole arrangement, either of the light grey paper alone or with the patterns on it as the case may be. This is to ensure that the bees do not train themselves to the smell of the light grey paper.

During training the perspex, over which sugarwater drops are laid, is cleaned at frequent intervals by means of a moist cloth. This precaution is taken to ensure that the bees do not associate the bee scent with food. This has been shown to occur in *A. mellifera* and so is suspected to occur also in the Indian species of honeybees. Care is also taken during training to see that the bees do not form large clusters round a single sugarwater drop; for if this is allowed to happen the bees might get trained to an accumulation of their own shapes and colour, instead of to the light grey colour and this factor may distort the results to be obtained in the test.

After training to the light grey background, tests are performed with figures on which the bees had not been fed. In the test, two specimens each of two patterns for which the bees' inborn preference is to be tested are kept on the light grey paper which is already on the training table, and this whole arrangement is covered over by a new clean sheet of perspex. The patterns are laid out on the table in such a manner that all of them have an equal chance of being visited by the bees. In the tests, no sugarwater drops are offered over the perspex. Ordinary water drops were offered instead on the perspex directly above the patterns, in some of the tests, while in the rest there were no drops. The presence of water drops in the test merely serves to enhance the number of visits on all the patterns offered, but does not materially alter the nature of the results. In the tests where the perspex is raised, the presence of water drops greatly facilitates accurate recording of the number of visits, which is otherwise very difficult. The number of visits that the bees pay to each of the patterns offered is recorded. When a sufficient number of visits have been recorded the test is closed down, and training the bees to light grey paper is resumed in the manner described above.

During each test the experimental table is turned once through an angle of 90°, so as not to give any pattern (also called 'figure' in this paper) an advantage over the other only because of its position.

The reaction of bees to figures were tested under two main conditions:

(a) with the figures covered only with a layer of perspex, and

(b) with perspex raised over the figures so that it covered the whole arrangement at a distance of $1\frac{1}{2}''$. For this purpose a frame was designed which could be used to raise the perspex and which, at the same time, prevented the entry of the bees from below it.

4. OBSERVATIONS

The results obtained in the experiments with the two species of honeybees are recorded below in the form of tables. The signs in the column at the extreme right in the table show which pattern (the less subdivided or the more subdivided) out of a pair is preferred by the bees, and to what extent? The signs used to indicate the preferences are +, + +, and + + +. These are explained below Table 1. The preferences shown by the bees in these experiments are entirely spontaneous or inborn, inasmuch as the tests are not preceded by training the bees to any particular pattern. It is significant that the choice between the two patterns by the bees is based on relative and not on absolute characters of the patterns in question.

Table 1 and 2 show the results of experiments with *A. indica* in which the star and the chequerboard series of patterns respectively were used. Tables 3 and 4 record the results of experiments with *A. florea* in which also the star and the chequerboard series of pattern respectively were used.

TABLE 1

Apis indica. Star series of patterns

Expt. No.	Patterns offered	Perspex raised or not ?	Percentage of visits on each of the patterns	Total No. of visits	Remarks*	
					Less sub.	More sub.
1	A & B	No	A-33·3, B-66·7	42		+ +
2	B & C	No	B-33·3, C-66·7	120		+ +
3	C & D	No	C-50 , D-50	32	equal	equal
4	C & D	Yes	C-71·4, D-28·6	49	+ +	
5	D & E	No	D-54·2, E-45·8	35	+	
6	Black disc & E	No	Black 13·6, E-86·4	44		+ + +
7	B & E	No	B-33·3, E-66·7	37		+ +
8	B & E	Yes	B-71·4, E-28·6	63	+ +	
9	A & E	No	A-32·5, E-67·5	40		+ +
10	A & C	No	A-25, C-75	32		+ + +
11	A & C	Yes	A-67·5, E-32·5	40	+ +	
12	M15 & E	No	M15-15·3, E-84·7	13		+ + +
13	M15 & E	Yes	M15-52, E-48	48	+	
14	M15 & D	Yes	M15-46·2, D-53·8	54		+

* Slightly preferred +, preferred + +, greatly preferred + + +.

TABLE 2

Apis indica. Chequerboard series

Expt. No.	Patterns offered	Perspex raised or not ?	Percentage of visits on each of the patterns	Total No. of visits	Remarks	
					Less sub.	More sub.
1	B′ & E′	No	B′–75·5, E′–24·5	49	+ + +	
2	Black sq. & C	No	Black–20, C′–80	35		+ + +
3	B′ & D′	No	B′46·6, D–53·4	30		+
4	B′ & D′	Yes	B′–67, D′ –33	59	+ +	
5	D′ & E′	No	D′–81, E′–19	37	+ + +	
6	Black sq. & E	No	Black–29·6, E′–70·4	27		+ +
7	M15 & D′	Yes	M15–63·1, D′–36·9	38	+ +	

TABLE 3

Apis florea. Star series of patterns

Expt. No.	Patterns offered	Perspex raised or not ?	Percentage of visits on each pattern	Total No. of visits	Remarks	
					Less sub.	More sub.
1	A & B	No	A–34·7, B–65·3	46		+ +
2	A & B	Yes	A–45·9, B–54·1	49		+
3	A & C	No	A–23·8, C–76·2	88		+ + +
4	A & C	Yes	A–38·9, C–61·1	77		+
5	A & D	No	A–26·8, D–73·2	97		+ +
6	A & D	Yes	A–50·5, D–49·5	175	equal	equal
7	A & E	No	A–24·3, E–75·7	111		+ + +
8	A & E	Yes	A–47·1, E–52·9	89		+
9	B & E	No	B–39.4, E–60·6	152		+
10	C & D	No	C–55·3, D–44·7	94	+	
11	D & E	No	D–52, E–48	104	+	
12	M15 & D	Yes	M15–49·7, D–50·3	119	equal	equal

TABLE 4

Apis florea. Chequerboard series

Expt. No.	Patterns offered	Perspex raised or not ?	Percentage of visits on each pattern	Total No. of visits	Remarks	
					Less sub.	More sub.
1	A′ & B′	No	A′–42·6, B′·57·4	54		+
2	A′ & C′	No	A′–24·3, C′–75·7	82		+ +
3	A′ & D′	No	A′–27·3, D′7·27	117		+ +
4	A′ & D′	Yes	A′–46·4, D′·53·6	114		+
5	A′ & E′	No	A′–48·7, E′–51·3	78		+
6	D′ & E′	No	D′–55·5, E′–44·5	63	+	
7	D′ & E′	Yes	D′–55, E′–45	69	+	
8	M15 & D′	Yes	M15–48, D′–52	98		+

5. DISCUSSION

One of the most significant and interesting results obtained from the present study was that both the species of honeybees, even when they were trained to feed only from a uniform light grey surface, visited in overwhelmingly large numbers the black-on-light grey patterns offered to them in the test, whereas the grey background to which the bees had been trained attracted only very few.

In *A. indica* it is seen (Table 1) that among pairs of star patterns which differ but little from each other as regards the amount of contour (or the degree of subdivision) they present, the more subdivided figure is nearly always preferred (though sometimes only slightly) to the less subdivided one, as seen in Experiments 1 and 2, or at least the less subdivided figure is never preferred to the more subdivided one (e.g., Expt. 3). If the difference in the amount of subdivision is greater between the two figures, as in Expt. 10, the more subdivided pattern is markedly preferred to the less subdivided one.

If this inference is correct, then it is to be expected that the preference of the subdivided figure will cease (or even be reversed) as soon as the limit of the optical resolution of the pattern in question, by the eyes of the bee is reached. This supposition, in fact, seems to be correct in the case of *A. indica.* The results of Expt. 5 show clearly that a point is reached when the less subdivided figure (D) (text figure 1) is preferred to a more subdivided one (E). Thus, at the level of subdivision as exemplified by E, the limit of optical resolution for *A. indica* is reached.

Though we find in the abovementioned case that the less subdivided figure is slightly preferred to the more subdivided one, yet the difference in the percentage of visits between the two is small; that is to say, there is no sudden reversion of preference. This might be explained by the assumption (confirmed by direct observation) that the distance at which each bee discriminates between the two patterns is not constant, but varies round a certain median value, most probably according to a Gaussian curve. Consequently, for a certain number of bees which decide at a greater distance, the finer pattern will have become already blurred while other bees, flying low, still recognize and therefore prefer it.

If this interpretation is correct then the preference for the less subdivided figure should visibly increase if the bee is forced to make her choice between the two at a greater distance. This has been effected by the abovementioned device of raising the perspex so that the distance between it and the plane of the figures becomes 1½". In this case, 1½" is the minimum distance from which each bee can view both the patterns and choose between them. In fact, in Expt. 4 (Table 1) where this has been done the less subdivided figure C is definitely preferred to the more subdivided one D. This result is substantially different from the result obtained in Expt. 3, where the same patterns were used but without raising the perspex. The same phenomenon is even more strikingly illustrated by Expts. 7 and 8, as also by Expts. 10 and 11. In all these cases, the bees behave as if for all or most of them the more subdivided patterns E, D and even C become blurred when viewed from a distance of 1½″. We assume that such blurred star figures of black-on-light grey appear rather like medium grey discs to the bee. The fact that the finely divided star pattern D when confronted with a medium grey disc (M 15) under a raised perspex is almost exactly as attractive to the bees as the latter (Expt. 14) fits in with this assumption. The same holds for the star pattern E (Expt. 13). It is obvious that when the perspex is not raised above the plane of the figures, a greater proportion of bees will always be able to distinguish and prefer the finer pattern, hence even the border line pattern E is preferred to B (Expt. 7) and to A (Expt. 9). However, the preference of E is not quite commensurate with its degree of subdivision.

The results obtained, when the chequerboard series of patterns are offered to *A. indica* in pairs (Table 2), are in conformity with the results obtained with the star series and thus substantiate the hypothesis of the form discrimination of *A. indi*ca outlined above. The limit of optical resolution is reached for the bees at E′ (text figure 2) of the chequerboard series, as shown by Expt. 5. The only puzzling result is that of Expt. 7. Here the compact figure M 15 not only reaches the attractiveness of the finely subdivided figure D′ but surpasses it when the perspex is raised. This is contrary to the assumption that the visits on this could never more that equal those on D′, even if the chequerboard becomes completely blurred and therefore similar to a grey square of the same luminosity.

Results of a similar nature are obtained with *A. florea.* Results of Expts. 1, 3, 5, 7 and 9 in Table 3 illustrate the fact that the untrained bees when confronted with pairs of star patterns always prefer the more subdivided patterns to the less subdivided ones. These results are quite comparable to those obtained with *A. indica.* That, from a certain degree of subdivision of pattern, the preference of the bees is reversed in favour of the less subdivided figure is shown in *A. florea* by the result of Expt. 10. Here the less subdivided figure C is preferred (though slightly) to the more subdivided figure D. Thus it seems that for a certain amount of bees the limit of optical resolution of patterns is almost reached in *A. florea* between C and D of the star series of patterns. This is in contradistinction to the case obtained in *A. indica* where, as shown by Expt. 3 of Table 1, the limit of resolution is not quite reached between C and D. The fact that in *A. florea* the bees already prefer figure C to figure D seems to indicate that they have a lower visual acuity as compared with *A. indica.*

The result of Expt. 11 under Table 3 corresponds with the result of Expt. 5 in Table 1, thus showing that for both *A. florea* and *A. indica* the finely subdivided pattern E has less attraction than the less subdivided pattern D. Results of Expts. 2, 6 and 8 in Table 3 show that, as in *A. indica,* the preference is reversed in favour of the less subdivided pattern in *A. florea* when the perspex is raised 1½″ above the plane of the figures offered. The only result which does not fit in is that of Expt. 4 in Table 3. For this experiment seems to show that *A. florea* still prefers pattern C to pattern A, even when the perspex is raised by 1½″. This result differs from the result of Expt. 11 in Table 1 where under similar conditions *A. indica* showed a definite preference for pattern A over pattern C. Expt. 12 in Table C shows that for *A. florea* pattern D is very much similar to a medium grey disc when the perspex is raised to a height of 1½″ above the figures in the test. This result agrees with the result obtained with *A. indica.*

Table 4 contains the results of experiments on *A. florea* in which the chequerboard series of pattern were used. In experiments 1, 2 and 3 the patterns displaying greater contour are preferred to those showing less. Expt. 5 shows that the most subdivided pattern of the series, E′, is slightly preferred to the least subdivided one, namely A′. Unfortunately the same experiment was not performed for *A. indica* but a closely comparable experiment, Expt. 1 in Table 2, shows that the most subdivided pattern E′ is not preferred to one of the less subdivided patterns B′. In fact B′ is nearly thrice as much visited as E′. This fact seems to indicate that *A. florea* has a greater visual acuity than *A. indica.* But this is contradictory to the previous hypothesis. Also Expt. 8 shows that, unlike *A. indica,* the medium grey M 15 is confused with pattern D′ when the perspex is raised in the test to a height of 1½″. Other results in Table 4 are similar to those obtained with *A. indica.*

Thus, as in the case of *A. mellifera,* a figure or pattern which presents a greater contour is preferred to one with less both by *A. indica* and *A. florea.* This preference, however, is shown only as long as the eye of the bee is able to resolve a pattern as such. Beyond that limit the preference of the more subdivided figure is reversed, most probably because such a figure seems blurred to the bees. In my experiments the reversal which occurred when the distance between the contours reached a certain absolute value was not sudden but gradual. This points to the fact, confirmed by observation, that the distance at which the bees make their choice between alternative patterns is not the same for all of them, but there is a median value around which the other values of distance lie, most probably along a Gaussian curve. It is intended, in future work, to obtain comparative values of visual acuity for the different species of honeybees by introducing an arrangement whereby the bees would be compelled to make their choice between different patterns at certain constant distances. The results obtained are likely to lead to a more definite conclusion than is possible on the basis of the present work, purely from the point of view of difference, if any, in the visual acuities of the different species of bees. The results thus far obtained seem to suggest that *A. florea* might have a slightly greater visual acuity than *A. indica.*

6. SUMMARY

As in the case of the European honeybee, *A. mellifera,* a pattern which presents a greater contour is spontaneously preferred to one with less, both by *A. indica* and *A. florea.* This preference is shown only as long as the bee's eye is able to resolve a pattern as such. Beyond that limit the preference of the more subdivided figure is reversed, most probably because such figure seems blurred to the bees. This reversal is not sudden, but gradual. This points to the fact that the distance at which the bees make their choice between alternative

patterns varies for different species of bees around a median value, most probably along a Gaussian curve. The results thus far obtained seem to suggest that *A. florea* may have a slightly greater visual acuity than *A. indica.*

7. ACKNOWLEDGEMENTS

I am greatly indebted to Dr. Dora Ilse for suggesting this problem, helping me with the literature, and for valuable assistance in the interpretation of results. My grateful thanks are due to Prof. M. A. Moghe for extending all the facilities for completing this work and for making very useful suggestions regarding this paper. I also thank Shri J. F. D'Souza of Poona who very kindly permitted me to work with the hive of *A. florea* situated in his compound. Finally, I wish to express my gratitude to the authorities of the Bombay Natural History Society for giving me a research grant and for their sympathetic attitude and constant help.

REFERENCES

Frisch, K. V. (1914): Der Farbensinn und Formensinn der Bienen. *Zool. Jb. Abt.* 3, 35: 1-188.

Hertz, Mathilde (1929 a): Die Organisation des Optischen Feldes bei der Biene, I. *Z. vergl. Physiol.* **8**: 693-748.

— — — (1929 b): Die Organisation der Optischen Feldes bei der Biene, II. *Z. vergl. Physiol.* **11**: 107-45.

— — — (1935): Die Untersuchungen über der Formensinn der Honigbiene. *Naturwissenschaften* **23**: 618-24.

Ribbands, Ronald (1953): The behaviour and social life of honeybees. B. R. A., London.

Wolf, E. (1933a): Critical frequency of flicker as a function of intensity of illumination for the eye of the bee. *J. gen. Physiol.* **17**: 7-19.

— — — (1933b): Das Verhalten der Bienen gegenüber flimmenden Feldern und bewegten objecten. *Z. vergl. Physiol.* **20**: 151-61.

Wolf & Zerrahn-Wolf, Gertrud (1935): The effect of light intensity, area and flicker frequency on the visual reactions of the honeybees. *J. gen. Physiol.* **18**: 853-63.

Zerrahn, Gertrud (1933): Formdressur und Formunterscheidung bei der Honigbiene. *Z. vergl. Physiol.* **20**: 117-50.

BIONOMICS OF THE PUMPKIN CATERPILLAR—*MARGARONIA INDICA* SAUND. (PYRALIDAE: LEPIDOPTERA)[1]

BY

R. C. Patel, M.SC. (AGRI.),
Institute of Agriculture, Anand

AND

H. L. Kulkarny, M.SC.,
Professor of Agricultural Entomology,
College of Agriculture, Dharwar

(*With a plate and a graph*)

Introduction

The pumpkin caterpillar, *Margaronia indica* Saund., is noted as one of the important insect pests of cucurbitaceous vegetables grown in this part of the world. The caterpillars attack both leaves and fruits and thus cause considerable damage. The damage to fruits is a direct loss and is prominently noted during August and September. Weekly observations taken during the period of investigation showed that the caterpillars occur on the crop from the first fortnight of June to the second fortnight of November, i.e., up to the pruning time of the crop. The peak of infestation was, however, noticed after 3 to 4 weeks of initial infestation. During 1953-54, the attack was initially noted on parwar (*Trichosanthes dioica* Roxb.) which subsequently spread on tondli (*Coccinia indica* W. & A.) crop.

Methods and Materials

The pest was commonly found on tondli and parwar. To judge the incidence of the pest in the fields, three leaves of different stages of growth were selected at random and the population level was recorded. Every week 10 different vines were selected at random and the average incidence of the pest on a medium-sized leaf was worked out. The incidence of the pest damaging the fruits was noted by observing 100 fruits at random. The larvae were reared on tondli leaves in the laboratory in glass petri dishes or glass bowls. The leaves were maintained green and succulent by keeping wet cotton-wool plugs at their petioles. The pupae, as they formed, were taken out, sexed and kept in separate dishes until emergence of the adults. The sex of the moths as they emerged was confirmed and individual pairs were introduced in glass chimneys with hanging paper strips. The moths were fed on sugar solution. The moths laid eggs on the paper strips. Fresh strips were substituted and those with eggs were removed for egg counts. Permanent mounts of the insect material were prepared following the usual method. The material was treated with concentrated chlorine water subsequent to potassium hydroxide treatment, in order to decolorise the material satisfactorily. It was then washed, dehydrated in ascending series of alcohol, cleared in clove oil and mounted in balsam.

---

[1] Being a part of the thesis for the M.SC. (Agri.) degree submitted to the Gujarat University by the former author under the guidance of the latter.

Historical Review

Hampson (1896) recorded the insect as damaging cotton leaves throughout the Australian and Oriental regions. In India it was first recorded by Lefroy and Howlett (1909) on cucurbits. Fletcher (1914, 1921) has given a general description of the life stages of the insect and has reported that it occurs in the plains of India, Burma, and Ceylon on snake gourd, cucumber, turia (*Luffa*), *Cucurbita pepo,* and kaddu. Ramkrishna Ayyar (1923, 1940) observed that it occurs on melon and various other cucurbitaceous crops. He has briefly described some of the life stages without giving the details regarding its bionomics. Other important records are by Pruthi (1936) and Sevastopulo (1948) from India, by Gosh (1925) from Burma, and by the Entomological staff (1923) from Ceylon. Vayssiere and Mimeur (1925) observed that in French Sudan it occurs on egg-plant and cotton. According to them the larval and pupal stages last for 16 and 11 days respectively. In Queensland, May (1946) found it to be most common on watermelon. He observed that the larval and the pupal periods last for 3 weeks and 5 days respectively.

Geographical Distribution

The insect has been recorded by various authors from various Indian territories, Burma, Ceylon, Fiji, Oriental and Australian regions, Netherland Indies, Samoa, Mauritius, Tonga Island, Indo-China, Japan, French West Africa, French Equatorial Africa, West Africa, and French Sudan.

Host-plants

Within India the insect has been reported to feed on snake gourd, cucumber, turia (*Luffa*), *Cucurbita pepo,* kaddu, melon and cotton. Outside India, it is reported as feeding on *Momordica charantia* L., *Ficus glomerata* Roxb., snake gourd, melon, New Guinea bean (a cucurbitaceous plant), pumpkin, cotton, soyabean, cucumber, and egg-plant.

However, at various farms of the Institute of Agriculture, Anand, Bombay State, the insect was found breeding on parwar (*Trichosanthes dioica* Roxb.), tondli (*Coccinia indica* W. & A.) and bottle gourd (*Lagenaria vulgaris* Seringe).

Nature of Damage

The larva feeds on the lower surface of the leaves leaving the epidermis of the opposite side in the form of a thin papery translucent membrane. It binds up two adjacent leaves or folds up a single leaf and continues feeding while remaining inside the fold. The areas attacked by the caterpillars show various irregular patterns of different sizes. Generally the caterpillars remain stationary while feeding and consequently continuous patches of damaged areas result on the host leaves. The damaged patches then dry out, with the result that the leaves get distorted. The larvae attack the tender fruits and often start feeding on the ovary of the flowers and thus the fruit formation is much hampered. Well-developed fruits with hard rind are not damaged, but a good number of developing fruits are attacked. The larva bores a small hole in the fruit for its entry and eats away the inner part, thus rendering it useless.

STUDIES ON LIFE-HISTORY

The Egg: (Plate, fig. A).

The eggs measure on an average 0.799±0.037 mm. along the longer axis and 0.488±0.035 mm. in width. They are thin-walled, normally oval, laid flat, and barium yellow[1] when viewed against a white background. Generally they are laid singly on the undersurface of the host leaves. To study the distribution of the eggs laid, 112 eggs were examined and it was found that 46 were laid singly, 16 in groups of 2 each, 12 in groups of 3 each, 8 in groups of 4 each, and a single group each of 7, 8 and 15 eggs. The moths did not show any marked preference as to the host material for laying the eggs.

Although the natural shape of the eggs when laid is cylindrical with bluntly rounded ends, the shape varies according to the pressure on its flexible chorion from the surfaces on which they are laid. The chorion is thin, transparent, and appears with pentagonal reticulations when viewed under high magnification (Plate, fig. B). Appearance of the larval eyes in the form of two dark spots on one end indicates the nearness of the end of the incubation period. The incubation period of eggs varied from 3 to 6 days under different conditions of temperature, whereas at a constant temperature of 87.0±1.5°F. they took 3.0 days to hatch. The data obtained are given below: (Table 1.)

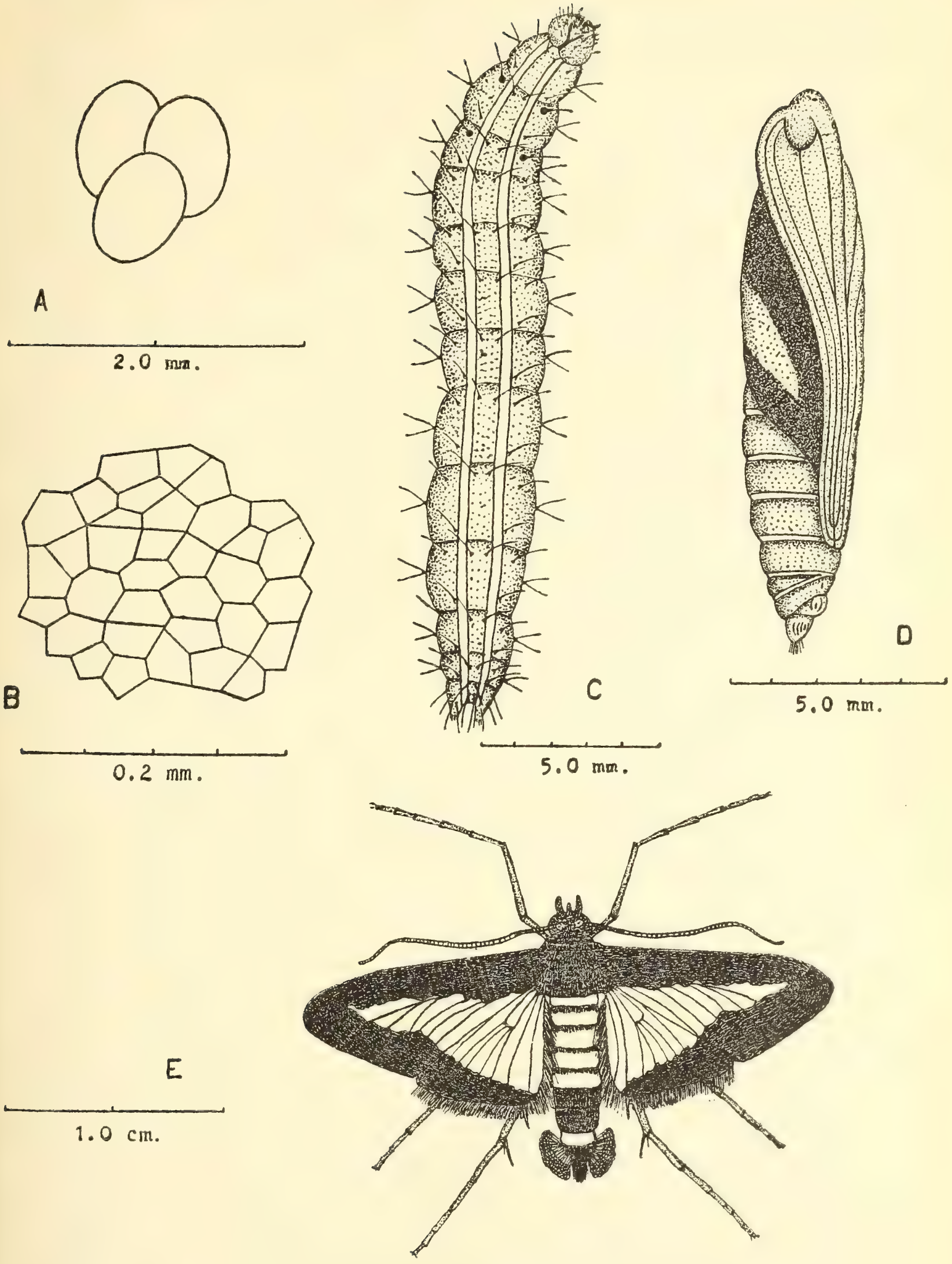
TABLE 1

Incubation period of eggs of *Margaronia indica* Saund.

S. No.	Period of study	Temperature in °F		No. of eggs observed	Incubation period of eggs in days	
		Average	(Min.—Max.)		Average	(Min.—Max.)
1	August 5 to 13, 1952	77·0	(73·0—80·0)	265	4·0	(4—4)
2	January 10 to 19, 1954	68·18	(60·9—80·0)	382	5·8	(5—6)
3	Incubator	87·0±1·5	...	395	3·0	(3—3)

---

[1] The colours have been described following Ridgway (1912).


A
2.0 mm.
B
0.2 mm.
C
5.0 mm.
D
5.0 mm.
E
1.0 cm.

The Pumpkin Caterpillar, *Margaronia indica* Saund.

A.—Eggs.
B.—Reticulation on the egg chorion.
C.—5th instar larva.
D.—Pupa of *M. indica* Saund.
E.—Adult.

From the data presented in the table, it is evident that with the increase in mean temperature, the incubation period of eggs decreases considerably.

The Larva:

The tiny larvae break the egg-shell near their head region at the time of hatching. They move about for some time and later become semi-stationary. In the first two instars, they feed very little. The caterpillars show a distinct tendency to move beneath the leaves irrespective of the leaf surface presented to them. The larvae, prior to moulting, turn pale yellow and suspend feeding. Subsequent to moulting the larvae appear mineral green in colour, are more active, and feed vigorously. They pass through 4 or 5 instars in their larval life of 9 to 14 days.

The full-grown Larva: (Plate, fig. C).

The full-grown larva measures on an average 18.5 mm. in length and is greenish with a pair of white streaks, running more or less parallel from the prothoracic region to the last abdominal segment. These streaks are not well marked in the freshly emerged larvae.

Head: The head is rectangular with a few setae and well-developed epicranial suture. *Ocelli:* 6 pairs of which one pair is posterior to the base of the respective antenna and the remaining five pairs are arranged still posteriorly in a semi-circle. *Antennae:* 3-segmented, situated outside the arms of the epicranial suture. Segment II is about two and half times longer than segment I. Two small conical sensillae and two setae arise from the tip of the segment II. Of these setae one is about twice the length of the whole antenna. Segment III is the smallest of all with 3 apical sensillae.

Thorax and abdomen: Mesothoracic and metathoracic terga present a pair of black specks placed at the base of the subdorsal seta. The larva possesses 3 pairs of well-developed thoracic legs each having a single claw at the distal end. Prolegs, 5 pairs in number, are present on 3rd, 4th, 5th, 6th and 10th abdominal segments. The chaetotoxy of the body segments was observed to be similar. Each segment presented 6 setae on the dorsal side and two pairs of setae arising side by side on the lateral sides. All these setae arise from the apices of minute tubercles and form definite longitudinal rows of setae on the body.

At the time of each moulting the neck-membrane behind the head capsule showed a crosswise split dorsally through which the larva wriggled itself out by alternate expansion and contraction of the body. Prior to moulting, the larva turns pale yellow or yellowish green, but it assumes a mineral green colour subsequent to moulting. Before the prepupal stage, when the larva is full fed, the colour changes to apple green with prominent white streaks. It remains well attached to the leaf surface and shows reduction in length. With the cessation of feeding the larva begins to fold the leaf to prepare its cocoon. At this stage the white streaks disappear and the larva appears lustrous neva green in colour. The cocoon is prepared in two sections. The outer loose cocoon is prepared by binding the leaves together and it provides the bedding for the inner cocoon. The inner cocoon which covers the larval body is suspended in the hollow of the outer cocoon. The outer loose cocoon prepared by the larva measured on an average 28.4 mm. and the inner cocoon, which is also loosely spun of silken threads, measured on an average 15.7 mm. The prepupal length of the caterpillars measured from 13 to 14.5 mm.

Duration of the larval period.

Studies on larval duration were conducted during 1952 and 1953. The data collected are presented in Table 2.

From the table it is observed that the larval duration is longer in the first and last instars. The larvae passed through four or five instars during different periods of study. The larval duration during the second half of September is observed to be 11.6 days and 12.0 days when the temperature in the laboratory varied from 76.0°F. to 87.0°F. with a mean of 81.68°F. During the latter half of December 1953 the larval period is observed to be 13.04 days when temperature in the laboratory ranged between 64.0°F. and 89.0°F. with a mean of 75.73°F. In the incubator maintained at 87.5 ± 1.5°F. the larval period is completed within 9 to 12 days with an average of 10.45 days. The larval period in general varied from 9 to 14 days, during different periods of study.

Food consumption and growth of larvae.

An elaborate experiment was arranged with a view to finding out the daily food consumption and the rate of increase in the body-weight of the larva during the period of its growth. The food consumption was obtained by recording the area of host leaf consumed by the caterpillar in 24 hours. The weights were recorded daily in the morning at 8 a.m. on a sensitive chemical balance. Fresh food was then supplied to the caterpillar for feeding. Table 3 gives the data collected during the experiment. During the period of experiment, the temperature in the laboratory ranged between 76.0°F. to 87.0°F. with a mean of 81.68°F.

The average food consumption and the average body-weight gained by the caterpillars are shown on the graph. From this as well as from Table 3 it will be observed that the caterpillars feed comparatively little during the first five days and also gain very little in their body weights. During the three days prior to prepupal condition, they feed voraciously and also gain in their body weight quite considerably.

The Pupa (Plate, fig. D).

The pupa is typically of an obtect type. The freshly formed pupa is mineral green with pale yellow intersegmental region. Subsequently, the body-coloration becomes dark brown. The pupae measured from 12.0 to 14.5 mm. in length and from 3.0 to 3.5 mm. in width. It is bluntly rounded towards the head region and tapers posteriorly to a point with 8 apical cremasters equally situated on lateral sides. With the aid of the cremasters the pupa remains well attached to the cocoon.

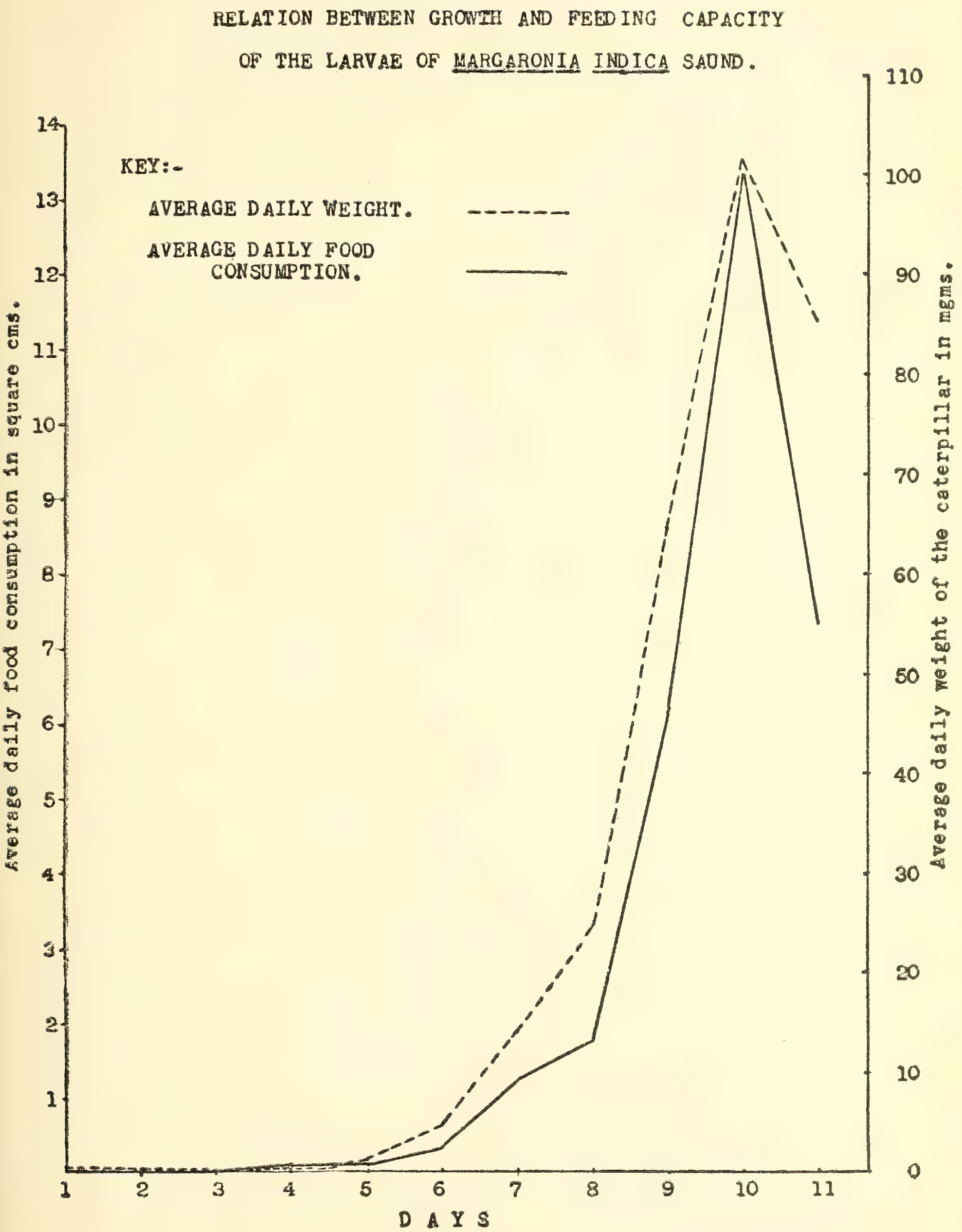

RELATION BETWEEN GROWTH AND FEEDING CAPACITY
OF THE LARVAE OF MARGARONIA INDICA SAUND.
KEY:-
AVERAGE DAILY WEIGHT.
AVERAGE DAILY FOOD CONSUMPTION.
Average daily food consumption in square cms.
Average daily weight of the caterpillar in mgms.
14
13
12
11
10
9
8
7
6
5
4
3
2
1
110
100
90
80
70
60
50
40
30
20
10
0
1
2
3
4
5
6
7
8
9
10
11
DAYS

TABLE 2

The number and duration of the larval instars of *Margaronia indica* Saund.

Period of study	Temperature during the period of study (°F.)		No. of observations	Average duration of the larval instars in days					Larval duration in days	
	Average	(Min. – Max.)		I	II	III	IV	V	Average	(Min. – Max.)
September 15 to 30, 1952	81·68	(76·0 – 87·0)	10	3·4	1·2	2·0	5·0	...	11·6	(11 – 12)
			4	3·5	1·0	2·0	1·0	4·5	12·0	(12 – 12)
December 15 to 31, 1953	76·73	(64·0 – 89·0)	27	2·85	2·00	1·85	2·19	4·15	13·04	(12 – 14)
Incubator	87·5 ± 1·5	...	33	2·09	1·24	1·48	5·64	...	10·45	(9 – 12)

TABLE 3

Average daily food consumption (sq. cm. of leaf area of *Coccinia indica* W. & A.) and the weight (in mg.) of the caterpillars of *M. indica* Saund.

Age of larva in days	Daily consumption of leaf area in sq. cm. and daily body-weight in mg. of individual caterpillar									
	G_1		G_3		G_8		G_9		Average	
	A	W	A	W	A	W	A	W	A	W
1	...	0·2	...	0·2	...	0·2	...	0·2	...	0·2
2	0·01	0·3	0·012	0·3	0·02	0·3	0·01	0·3	0·013	0·3
3	0·017	0·4	0·00	0·3	0·036	0·4	0·030	0·4	0·021	0·38
4	0·16	1·0	0·069	0·4	0·19	0·4	0·04	0·6	0·115	0·6
5	0·25	2·2	0·077	1·0	0·038	1·2	0·14	1·0	0·126	1·35
6	0·402	4·4	0·45	4·0	0·48	5·0	0·38	4·8	0·428	4·55
7	1·83	18·6	1·27	14·4	0·85	10·2	0·95	13·2	1·225	14·1
8	3·30	43·4	1·10	18·6	1·04	17·0	1·52	20·2	1·74	24·8
9	2·45	57·4	8·45	76·6	5·6	49·0	8·15	75·2	6·16	64·55
10	5·10	61·6	16·85	125·6	11·45	98·8	19·9	120·0	13·33	101·5
11	2·82	50·2	10·30	96·0	10·35	92·8	5·85	102·0	7·33	85·25

A = Leaf area in sq cm, consumed by the caterpillar.
W = Weight of the caterpillar in mg.

Out of 104 pupae observed, it was noticed that a day prior to emergence of the adult, the pupae showed development of black bands along the margins of the wing-pads. Male pupae developed black coloration on the posterior end, whereas in female pupae no such coloration developed. At the time of emergence of the moth, the pupal covering ventrally showed a longitudinal split from the apex of the head to the second abdominal segment in the region of rostrum.

Sex Differentiation in Pupa.

In the male pupa, the 9th and 10th abdominal segments presented black coloration for a day prior to emergence of the adults. This development of black coloration is due to large number of black scales on the ventral side of the anal tuft of the male moth. No such coloration developed in the female pupae.

The position of the genital pores also differs in the male and the female pupae. In both sexes the anal aperture is situated on the ventral side of the 10th abdominal segment in the form of long dark streak with inwardly bent ridges at the sides. The genital aperture in the male pupa is situated on the 9th abdominal segment 0.2 mm. away from the anal aperture. In the female pupa it is situated on the 8th abdominal segment 0.54 mm. away from the anal aperture. The genital aperture in male and female pupae measured on an average 0.32 mm. and 0.29 mm. in length respectively.

Duration of the pupal period.

The results of various observations made on the duration of the pupal period are summarized below in Table 4.

TABLE 4

Duration of the pupal period of *M. indica* Saund.

S. No.	Period of study	Temperature in °F.		No. of pupae observed	Pupal period in days	
		Average	(Min.–Max.)		Average	(Min.–Max.)
1	Aug. 1 to 15, 1952	77·00	(72·0–82·0)	11	6·55	(6–8)
2	Aug. 19 to 27, 1952	79·66	(76·0–82·0)	14	6·07	(5–7)
3	Sept. 7 to 15, 1952	80·39	(75·0–86·0)	10	6·0	(6–6)
4	Sept. 16 to 28, 1952	81·88	(76·0–87·0)	38	5·92	(5–7)
5	Sept. 27 to Oct. 6, 1952	84·3	(79·0–92·0)	18	5·67	(5–7)
6	Dec. 26, 1953 to Jan. 14, 1954	71·58	(60·0–86·0)	19	9·90	(9–13)
7	Incubator—1	87·0 ± 1·5	...	16	5·75	(5–6)
8	Incubator—2	89·0 ± 1·5	...	17	5·24	(5–6)

From Table 4 it is evident that the pupal period varies with temperature. During August to October (average temperatures 77.0°F. to 84.3°F.) the period varied from 6.55 to 5.67 days. During December/January (average temperature was 71.58°F.) the period was 9.90 days. The shortest pupal duration observed was 5.24 days in the incubator maintained at 89.0 ± 1.0°F.

The Moth (Plate, fig. E).

The moth measured on an average 0.962±0.09 inches across the wings and 0.49 ±0.04 inches in length. The costal margin of the fore-wing is banded dusky drab in colour. The band is continuous on the head and first two thoracic segments. It further extends to the humeral margin of the forewing and hindwing and is continuous on the 5th and 6th abdominal terga. The rest of the wing is white with chinese violet lustre when held across the light. A globular tuft of scales is present at the posterior end of the abdomen. In male the scales in the middle are thickly set and present a black triangular patch on both the dorsal and ventral surfaces. In female the scales in the middle of the tuft are light coloured and the whole tuft appears orange in colour. The sex ratio worked out for 105 individuals was 54.29 females to 45.71 males.

Longevity and fecundity of M. indica Saund.

To study the egg-laying capacity of the female and the longevity of adults the moths were caged in glass chimneys in pairs. The data obtained are given in the table below:

TABLE 5

The longevity and fecundity of *M. indica* Saund.

Number of observation	Number of pairs	Pre-oviposition period in days	Oviposition period in days	Number of eggs laid by the female	Post-oviposition period in days	Total life in days	
						Male	Female
1	1	2	2	53	0	5	4
2	1	1	3	249	1	4	5
3	1	1	2	57	0	4	3
4	1	2	2	298	1	4	5
5	1	3	1	22	2	5	6
6	1	1	2	205	1	3	4
7	1	2	1	23	4	4	7
8	1	1	2	366	0	3	3
Average		1·63	1·88	159·1	1·13	4·0	4·63

The total adult life ranged between 3 to 7 days at the mean laboratory temperature of 81.0°F. The average pre-oviposition and post-oviposition periods were 1.63 and 1.13 days respectively. The oviposition period was, on an average, 1.88 days. The egg-laying capacity of a single female varied from 23 to 366 (average 159.1) eggs per female. The females survived a little longer than males.

SUMMARY

Although the Pumpkin Caterpillar has been recorded on wide varieties of host-plants from different countries, no complete record of its bionomics has hitherto been published. The egg, larval, and pupal periods varied from 3 to 6, 9 to 14, and 5 to 13 days respectively during different period of study. The egg-laying capacity of the female varied from 23 to 366 eggs. The pre-oviposition, oviposition, and post-oviposition periods varied from 1 to 3, 1 to 3 and 0 to 4 days respectively. In both pupae and adults the sexes differ morphologically. The number of larval instars varied from 4 to 5. The rate of feeding is greatly accelerated during the three days prior to the prepupal stage.

REFERENCES

1. Entomological staff (1923): A preliminary list of pests of cultivated plants. Ceylon. *Dept. of Agric. Bull.* **67**: 68.
2. Fletcher, T. B. (1914): Some South Indian Insects: 435-436.
3. — — — (1921): Annotated list of Indian crop pests. *Agric. Res. Inst. Pusa. Bull.* **100**: 86.
4. Gosh, C. C. (1925): Report of the Entomologist and sericulture work for the year ended 30th June 1925. Rangoon. pp. 10+8.
5. Hampson, G. F. (1896): Fauna of British India—Lepidoptera. **4**: 360.
6. Lefroy & Howlett (1909): Indian Insect Life: 518.
7. May, A. W. S. (1946): Pests of cucurbit crops. *Qd. Agric. J.* Brisbane **62** (3): 137-150.
8. Pruthi, H. S. (1936): Report of the Imperial Entomologist. Sci. Rept. Imp. Inst. Agric. Res. 1934-35. Delhi, pp. 141-152.
9. Ramkrishna Ayyar, T. V. (1923): Some insects noted as pests of fruit trees in South India. *Agric. J. India,* Calcutta **18** (1): 50-59.
10. — — — (1940): Handbook of Economic Entomology for South India. Madras Government Press, p. 268.
11. Ridgway. (1912): Colour standards and nomenclature. Washington D. C.
12. Sevastopulo, D. G. (1948): Food plants of Indian Geometridae and Pyralidae. *JBNHS,* **47** (3): 493-498.
13. Vayssiere, P. & Mimeur J. (1925): Les pyrales de Cotonnier (*Sylepta derogata* F. et *Glyphodes indica* Saund.) an Afrique occidentale francaise. *Agron. Colon. Paris,* **90**: 225-268.

THE BIOLOGY OF SCORPIONS[1]

BY

MAX VACHON

(*With a plate and 17 figures*)

INTRODUCTION

Scorpions are arthropods celebrated in both history and legend, and there is no lack of material for those seeking the reasons for their wide reputation for supernatural powers and their significance in painting and sculpture. Biologists, and palaeontologists too, can find much to interest them in scorpions. It is impossible to discuss here all the features which make them so fascinating; the present article is restricted to certain peculiar features of their biology and morphology, and attempts to explain some of the apparent contradictions which are found.

Scorpions and the related spiders belong to a group of arthropods that has been distinct for several hundred million years. Scorpions differ in many ways from insects, the whole head and thorax forming a single unit, the cephalothorax, covered by a shield. Behind the cephalothorax come an abdomen of seven segments and a tail with five, terminating in a further segment, the poison gland.

In front of the head there are two small pincer-like appendages pointing forwards; these are the chelicerae (figures 5, 8). There are

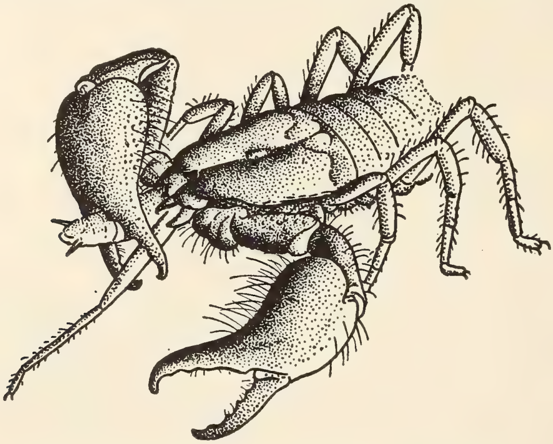


Fig. 8. *Heterometrus scaber* (Thorell) feeding.

---

[1] Reprinted from ENDEAVOUR, Vol. xii, No. 46 (April 1953), with the kind permission of its editor and publishers.

We are indebted to Dr. A. P. Mathew for the notes which appear within square brackets in the text. Also for kindly supervising the preparation of some of the figures, and supplying text figure 17—EDS.

five pairs of legs, the first pair of which, the pedipalpi, are strong and terminate in claws. The bases of these two legs form part of the mouth (figure 13). The remaining four pairs are alike, and are used for locomotion.

Behind the legs and covering the ventral part of the cephalothorax, i.e., at the start of the abdomen and behind the genital region (figure 13), there are a pair of curious appendages, the pectines or combs. These are peculiar to the scorpions, and are found in both young and old of both sexes. With the poison gland, they serve to distinguish scorpions from all other arthropods.

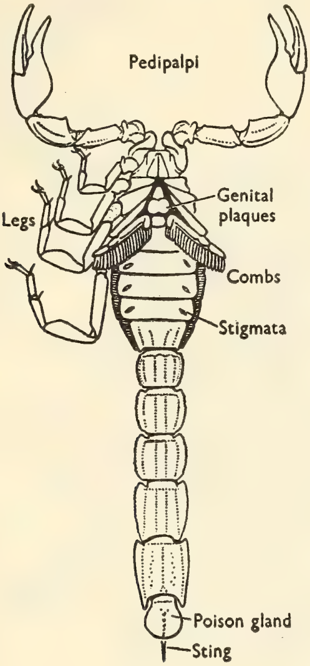


Fig. 13. *Androctonus australis* (L.), female. Ventral surface, showing the parts of the body. Total length 8 cm.

A rare anomaly, which has attracted much attention, consists in a doubling of the tail. Figure 1 shows an adult female with two identical tails, each perfectly formed. This division of the rear end of the body sometimes also affects a portion of the abdomen; it originates during embryonic development, a case of incomplete twinning. The anomaly was known in antiquity, for Pliny, citing Aelian, placed these double-tailed scorpions in a class by themselves.

SCORPIONS AS LIVING FOSSILS

Scorpions are one of the oldest forms of life still to be found on the surface of the earth. Only a few hundred fossilized specimens are known, but it must be remembered that we are dealing with a land animal whose chances of fossilization may well have been slight. Examples recorded from many parts of the world show us that the scorpions have remained essentially unchanged for hundreds of millions

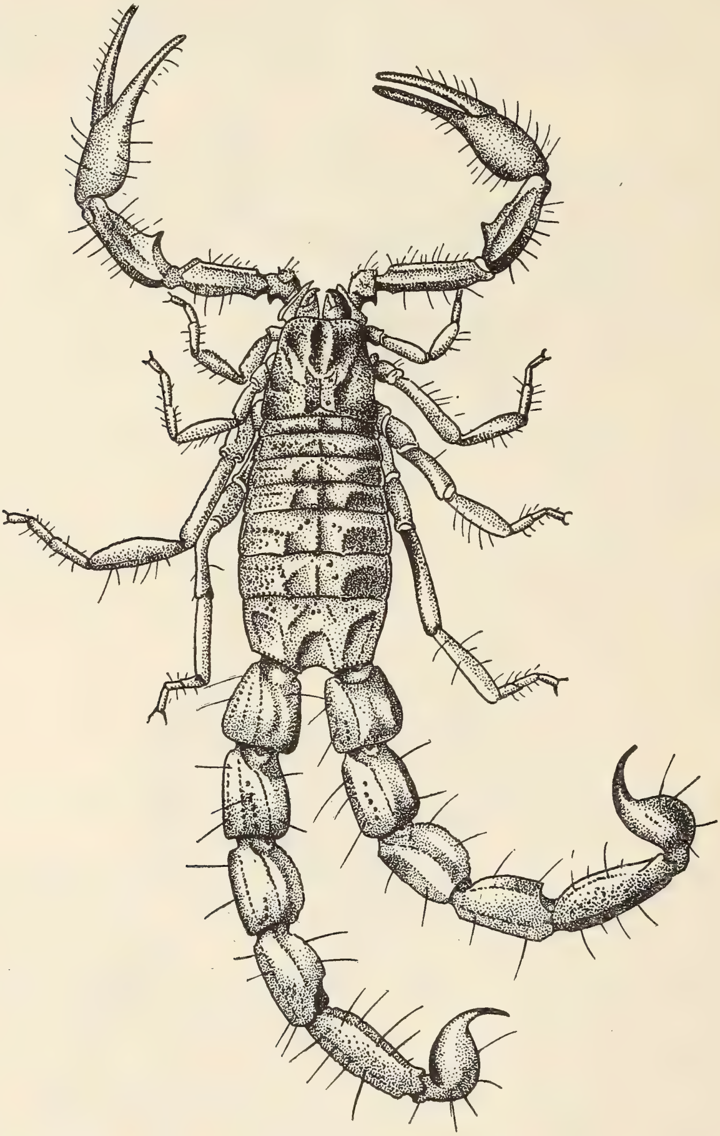


Fig. 1. *Buthotus alticola* (Pocock), adult female from Afghanistan, with two perfect tails. Length of body 9 cm. (After Gaillard).

of years. Fossil scorpions resemble the present-day *Pandinus* (figure 4) in possessing a pair of chelicerae, a pair of pedipalpi, four pairs of legs for locomotion, a poison gland, and ventral pectines. It is

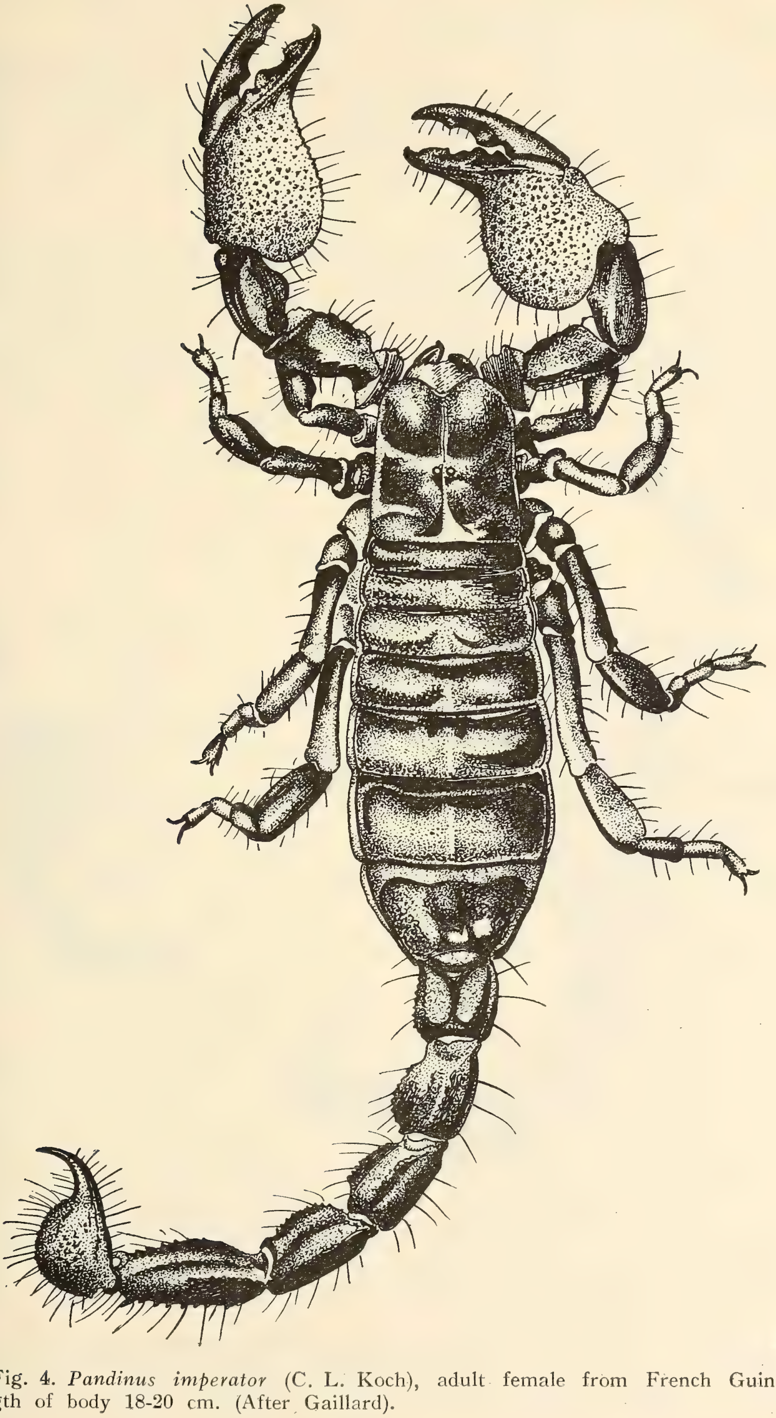


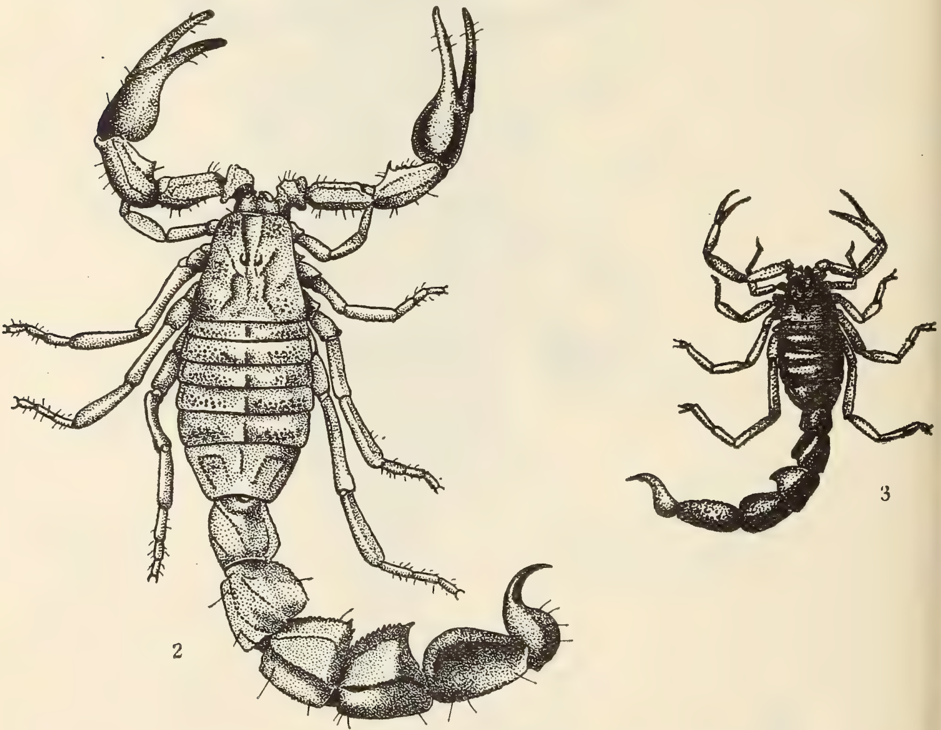
Fig. 4. *Pandinus imperator* (C. L. Koch), adult female from French Guinea. Length of body 18-20 cm. (After Gaillard).

thus impossible wrongly to classify a fossil scorpion, and modern scorpions may well be described as 'living fossils'.

It must not be assumed, however, that the scorpions have remained completely unchanged from the earliest times. It is possible to discern differences of detail between fossil and present-day scorpions which have resulted from an evolutionary process; these have been studied by the American arachnologist A. Petrunkevitch (5, 6).

The Stability of the Scorpions

During vast epochs of time, scorpions have been subjected, like other forms of life, to great geological and climatic changes. How have they been able to resist these changes, to adapt themselves to them, and to survive? I have recently published a revision of the north African scorpions (9), of which two examples (figures 2 and 3) are shown here, and in the course of this study I have put forward certain hypotheses to explain their sustained success.



Two characteristic scorpions from north Africa

Fig. 2. *Androctonus australis* (L.) *hector* C. L. Koch, a lethal species from the northern borders of the Sahara. Length of body 9.5 cm. (After Gaillard).

Fig. 3. *Orthochirus innesi* E. Simon, a species from the Saharan oases. Length of body 3 cm. (After Gaillard).

North Africa has not always been a desert as it mainly is today; in the course of time it has undergone a succession of wet and dry periods. After the final rainy period of the Quaternary, a long dry period set in which transformed a region of luxuriant growth into a desert. How did the Tertiary fauna withstand this catastrophe? The present distribution of the scorpions of the Sahara is characteristic: they are few in numbers and are split up into small colonies, last relics of a past greatness. There are regions virtually devoid of water where scorpions, like most other animals, have completely disappeared; there remain, however, large or small regions, from mountains to oases, where conditions, though much changed, still permit life to continue. Moreover, scorpions live in the soil, under stones, or in burrows, and they can thus relatively easily find surroundings which fulfil their requirements and which are to some extent stabilized. Finally, it must not be forgotten that even large changes in the general climate are much diminished in the superficial layers of the soil. Extensive researches into microecology, especially that of insects, indicate that the micro-climate in the layer beneath the surface is largely independent of the external general climate.

Scorpions have thus managed to survive in conditions of heat and drought, first because of their subterranean habitat, and secondly because there remain here and there areas where their old conditions of life still obtain. Above all, however, they have survived because of their ecological plasticity.

It is generally believed that scorpions are characteristic of dry or desert regions, but I consider this to be wrong. They are but the remains of an ancient fauna, still quite abundant, which lived under quite different conditions of temperature and humidity. If they have survived, it is because of their great adaptability—their capabilities are great, their demands few. I cannot sustain this argument here in detail, but I can mention some remarkable experiments on the feeding and respiration of scorpions. They can, for example, remain in an inert condition at freezing point for a period of weeks, and yet return in a few hours to a normal mode of life. They can withstand, without hurt, total immersion in water for days on end, or the blocking of seven out of their eight lungs (4). They have remarkable possibilities of haemopoiesis (i.e., making blood) and a very small respiratory coefficient. Moreover, they are sluggish creatures and thus consume little energy in moving about. More important still, they can gorge themselves with food in a few hours, or survive without feeding for many months, even for more than a year. In my opinion, scorpions are a striking example of creatures whose persistence derives not from the fact that their surroundings have remained unaltered, but from the fact that they are able to neutralize large changes in their surroundings by resorting to their subterranean habitat; in addition, their remarkable physiology enables them greatly to vary the tempo of their existence. Largely unaffected by extremes, they are virtually independent of their surroundings; herein lies the most certain guarantee of the immortality of their race.

Detection and Capture of Prey

The food of the scorpion consists of living creatures of many kinds that share its habitat, insects (both adults and larvae), spiders, millepedes, and even small rodents. The mode of capture of prey has often been observed, and descriptions by early naturalists are well known. Here I illustrate certain characteristic attitudes. At rest, or 'sleeping' (figure 5), the scorpion is motionless, with its ventral surface against the ground, the tail curved on the flat, and the legs folded. When hungry, or if a victim is detected, the attitude of the animal changes (figure 6); it moves slowly forward, supported on its hind legs, with claws open and extended and tail raised and pointing forwards. Often the scorpion will then hesitate, and the final act of

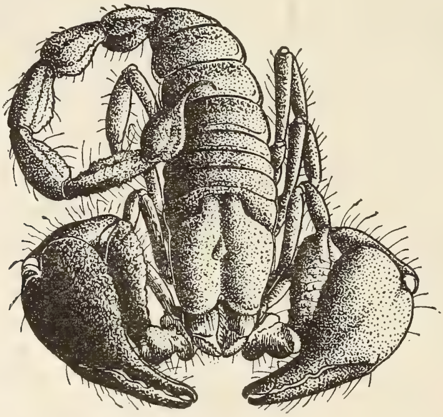


Fig. 5. *Heterometrus scaber* (Thorell) the large black scorpion of the West Coast of India. Length of body 13 cm. Posture at rest.

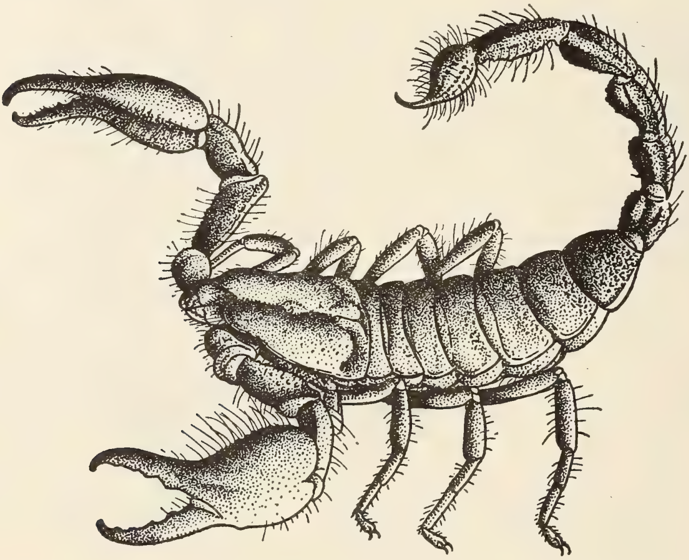


Fig. 6. *Heterometrus scaber* (Thorell). Posture when on defensive or in search of prey.

capture seems almost accidental, an act of defence rather than of attack. If the prey is active, the scorpion may even withdraw for a time, but it waits patiently and finally achieves its aim. Then, especially if the victim struggles, it inserts its sting (figure 7) where best it can, often without any delay, and the prey, held in the claws, is carried towards the chelicerae. These seize it and inflict deep wounds, through which the contents of the victim's body escape and pass into the scorpion's mouth. The chelicerae play the most important part in this operation. They break down the tissues of the victim, of which there finally remains nothing but a mass of unabsorbable residues; these are sometimes got rid of by using the claws as toothpicks.

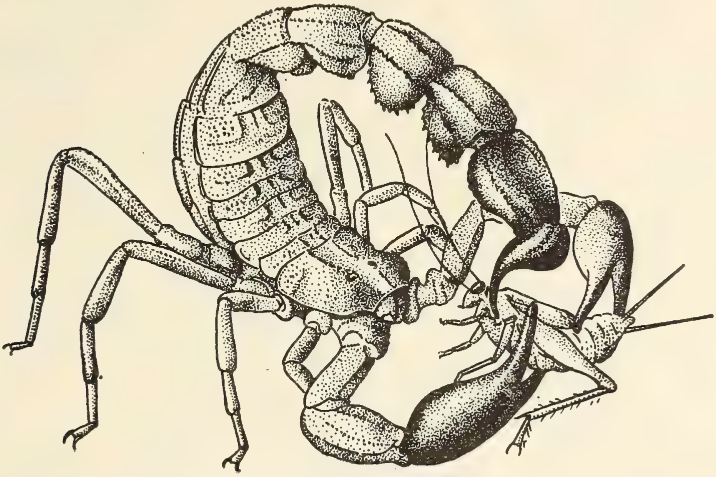
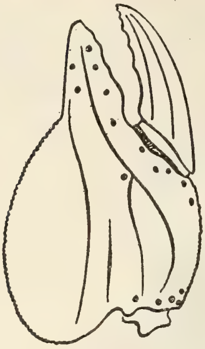
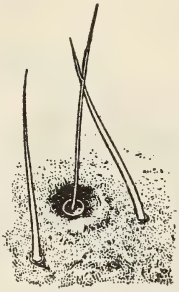


Fig. 7. *Androctonus australis* (L.) *hector* C. L. Koch, capturing and stinging prey.

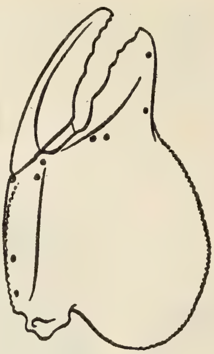
It is not entirely clear how the scorpion first detects its prey. The eyes are too crude to be of much assistance, and in any case the scorpion is a nocturnal animal for which visual impressions can be of no great significance. Other sensitive organs must therefore be concerned, notably the sensory hairs or trichobothria found only on the pedipalpi. These hairs are present at birth, and do not alter in number or position during growth. They are of considerable importance in classification (figures 10, 12), and certainly represent very primitive characters. The trichobothria are easily recognizable by the shape of their point of insertion, which resembles the top of a well (figure 11), by their fineness, and by the thinness of the membrane which links them to the integument. They are richly supplied with nerves, and can certainly detect minute air-currents such as those caused by movements of the prey. They are, in fact, like tiny receiving-sets, pointing in all directions and spaced out along the pedipalpi, which when extended act as huge antennae.



10



11



12

Fig. 10. Claw of *Scorpio maurus* (L.), a scorpion from north Africa, living in a burrow. External view, showing the sensory hairs.

Fig. 11. Sensory hair, much enlarged, between two ordinary hairs.

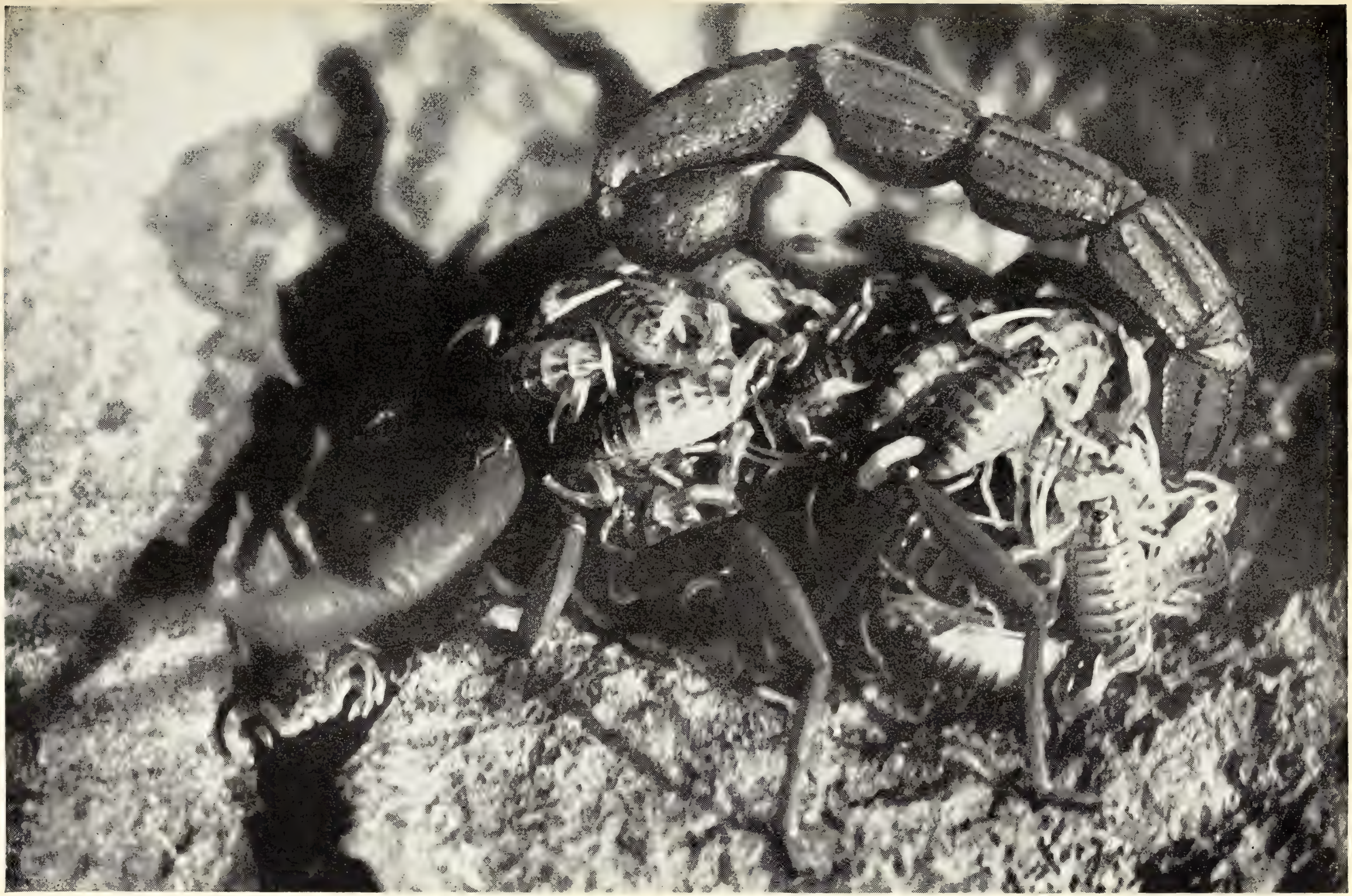
Fig. 12. Same claw as in figure 10 (internal view).

EXTERNAL DIGESTION

The scorpion has to macerate its prey, because the mouth is able to take in liquids only. There is a powerful pharynx, which sucks the liquid contents of the victim into the large middle intestine, where it can be digested. Scorpions are not peculiar in sucking their prey, but are unusual in that digestion is effected outside the body by means of powerful enzymes ejected periodically during feeding; in this they resemble some other arachnids. As the scorpion feeds, from time to time it ceases to suck and liquid is regurgitated upon the victim. It appears that this liquid originates in the middle intestine, which is rich in glandular tissue, and that the scorpion actually regurgitates its digestive fluid during its meal. The study of external digestion in other arachnids, particularly spiders and pseudoscorpions, leads to the belief that the breaking-down of the tissues of the victim is caused not only by this intestinal fluid but by secretions form, specialized glands, analogous to salivary glands, which are poured into or over the victim at the moment of regurgitation. The anatomy of the scorpion is not sufficiently well known for this analogy with other arachnids to be perfectly reliable, but it does seem that the regurgitated fluid is activated by other substances secreted from the specialized glands, and sometimes, as in certain spiders, by the poison itself. I have recently pointed out (8) that the poison must not be considered solely in connection with the capture of prey: it is related to the feeding-process as a whole and forms but a part, albeit the best known, of the physiological complex which constitutes the external digestion. In scorpions, too, the poison has its role in this complex; it not only cuts short the victim's resistance but aids, by catalytic or other chemical action, in the digestive process itself.

REPRODUCTION AND NUTRITION OF THE EMBRYO

In scorpions the sexes are distinct, though they resemble each other in all but small details. Fertilization necessitates the coming



The Rock Scorpion *(Buthus* sp.*)* with young on her back.

Scorpions bring forth living young. As soon as they are born they clamber on the mother's back and remain there till able to shift for themselves. The mother's 'tail' with its poison sting gives sure protection to the defenceless family.

Photo: O. C. Edwards

together of the two sexes and is accompanied by curious display. Maccary (2) and Fabre (1) have described some of these displays, the *promenades à deux* in which male and female walk 'hand-in-hand'; and the *arbre droit* in which the two animals appear to be fighting (figure 9). The conclusion of these nuptial dances I have not observed, but anatomical investigation bears out the statements of early writers; the male fertilizes the female directly in a true copulation, which is rather rare in other arachnids. In the course of this act, the male protrudes certain special organs to form a temporary penis, with which he inserts the sperm and finally places in position a vaginal plug, a kind of post-nuptial hymen (9, pp. 31-6).

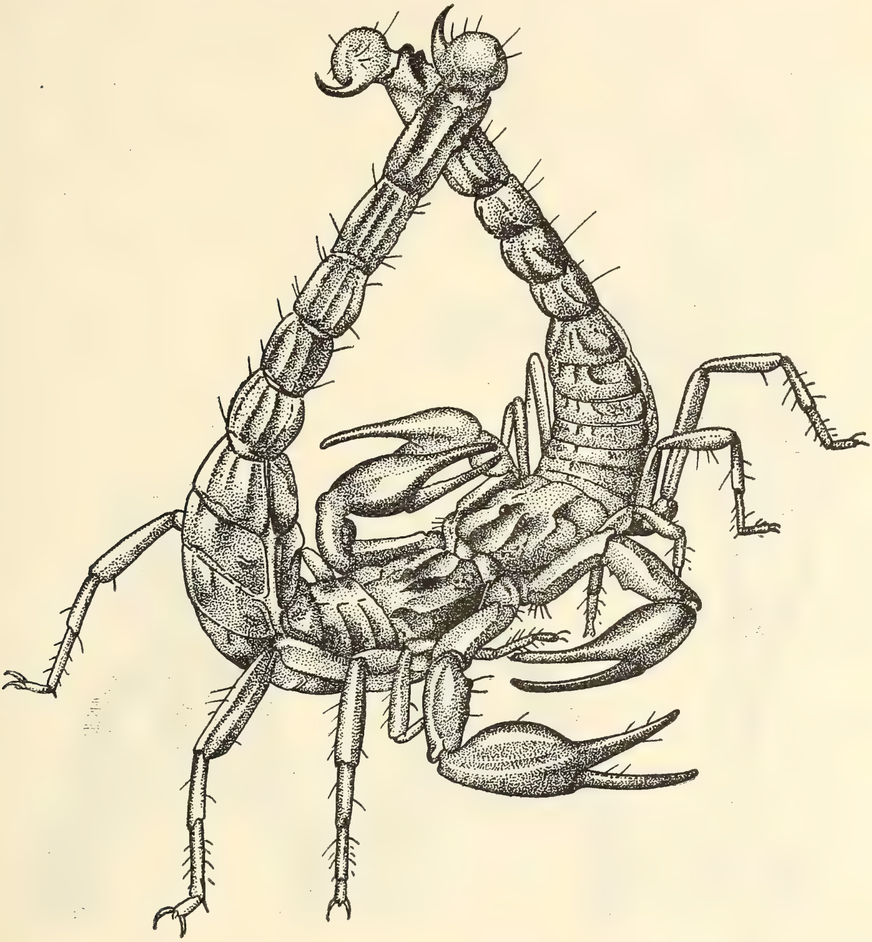
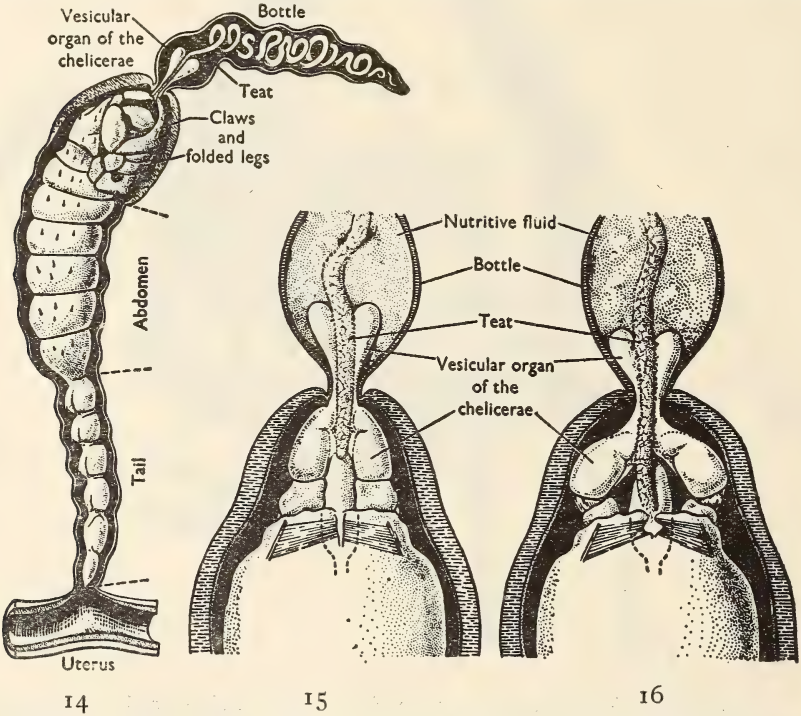


Fig. 9. Posture known as the *'arbre droit'* (after Fabre, and from personal observations) preceding copulation in *Buthus occitanus* (Am.), a scorpion from Languedoc, France. The female is on the left.

The course of development of the fertilized eggs inside the mother differs according to whether the eggs are rich in yolk (as in the

Buthidae) or are completely lacking in yolk (as in the *Scorpionidae*). In the first case, the eggs pass quickly into the oviduct and develop there, consuming the yolk with which they are filled [e.g., as in *Euscorpius, Isometrus, Buthus* etc.]; in the second, the fertilized egg remains in place and becomes closely commingled with the maternal tissues. At the end of its development [in the latter type] each embryo lies in a diverticulum which possesses a tubular extension. This extension, almost an umbilical cord, is applied to the wall of the mother's intestine, from which it draws off nutrients by osmosis. The food is transformed by glandular secretions and then led through the tube to the actual mouth of the embryo. We can almost speak of it as a bottle and teat process, since A. P. Mathew (3) has shown that at this stage the embryo scorpion has a well-developed pharynx and sucks the maternal fluid. Its chelicerae (figure 15) end in contractile vesicular organs which actually take hold of the teat and carry it to the mouth. I have described this remarkable process of embryonic nutrition [in *Ischnurus ochropus*] elsewhere (7). [The embryonic nutrition in the S. Indian *Heterometrus* (=*Palamnaeus*) *scaber* as described by Mathew (3 & 3a) is similar in



Figs. 14-16. Embryos of *Ischnurus ochropus* C. L. Koch, from East Africa.

(14) Diverticulum of the uterus containing an embryo, showing the 'feeding-bottle'.

(15 and 16) Diagrammatic representation of horizontal sections of the anterior part of the diverticulum, showing the relationship between the embryo's chelicerae and the teat; the latter can be carried to the mouth of the embryo by the chelicerae (fig. 16).

principle, but differs in many details (fig. 17).] We see that although so much alike in outward appearance, there exist great internal differences between various scorpions. In some the embryo is left to feed itself on the yolk of the egg, while in others embryonic nourishment is a complex affair resulting from a process of mutual adaptation between the organs of mother and young.

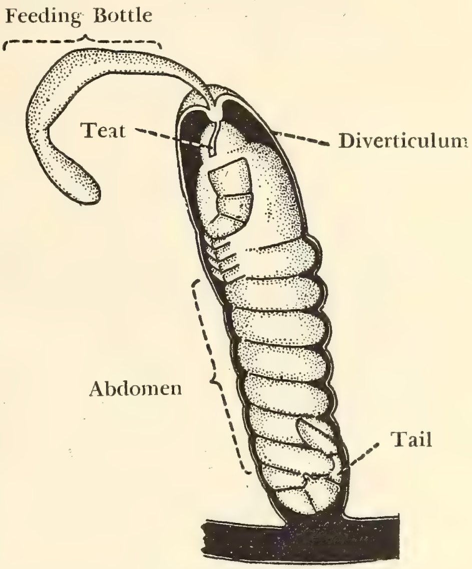


Fig. 17. Embryo of *Heterometrus scaber* in the diverticulum showing the 'feeding bottle' and its 'teat' which is inserted at the mouth opening. In the diagram the left chelicera and part of the pedipalp are removed so that the teat may be seen. (A. P. Mathew).

CONCLUSIONS

The scorpions are members of an ancient race whose fossils go back to very early times. Their essential morphology has remained unchanged for hundreds of millions of years, and this has gained for them the name of 'living fossils'. Yet they are none the less products of evolution. The complexity of their digestive processes, carried on in part outside the body, and the mode of nutrition of the embryo in some species, requiring a close adaptation between mother and young, both bear witness to an anatomical evolution of long duration. Equally, the complex system of the sensory hairs and the elaborate nuptial dances must have evolved over immensely long periods. Ecological studies show that scorpions possess a plasticity rendering them largely unaffected by external changes. They are an example of a type which early achieved a high degree of perfection; they have subsequently continued without substantially changing, degenerating, or disappearing, but also without giving rise to new forms.

REFERENCES

1. Fabre, J. H. (1923): 'Souvenirs Entomologiques.' J. H. Delagrave, Paris.
2. Maccary, A. (1810): 'Mémoire sur le Scorpion qui se trouve sur la Montagne de Cette.' Gabon, Paris.
3. Mathew, A. P. (1948): *Proc. Indian Acad. Sci.*, **27** (4): 111.
3a. — — — (1956): Embryology of *Heterometrus scaber* (Thorell) *Univ. of Travancore Res. Inst. Memoir*, **1**. (September).
4. Millot, J. and Paulian, R. (1943): *Bull. Soc. Zool. Fr.* **58**: 97.
5. Petrunkevitch, A. (1952): *Syst. Zool. USA*, **I** (i).
6. — — — (1952): *Amer. Scient.*, **40** (1): 99.
7. Vachon, M. (1950): *Arch. Zool. exp. gén., N. et R.*, **86** (3): 137.
8. — — — (1951): *C. R. Acad. Sci., Paris,* **233**: 205.
9. — — — (1952): 'Études sur les Scorpions.' Institut Pasteur d'Algérie.

SOME USEFUL WEEDS IN AND AROUND CUTTACK

BY

H. PATTNAIK

Lecturer in Botany, Ravenshaw College, Cuttack

INTRODUCTION

There is no systematic account of the Flora of Orissa State; no work of this nature has yet been done since its separation from Bihar in 1936. Haines (1925), Prain (1903), Bal (1942) and Mooney (1950) have not laid much stress on the detailed study of the flora of this State. Recently the Botanical Survey of Orissa has started with a view to discovering rare, economic and medicinal plants. This State has rich natural resources and there are many virgin forests with valuable plants in the ex-State areas. Some preliminary work has been done on the useful weeds of Cuttack and its neighbourhood.

Cuttack city is surrounded by two rivers, i.e., the Mahanadi and its branch the Kathjuri. The general soil of the city and its neighbourhood is sandy loam and also alluvial at some places. A number of weeds grow up in different seasons and these become abundant in the rainy season. Some of them are used locally as medicinal plants, foodstuff, and fodder. These weeds are not totally undesirable; some of them have various important uses. With a view to finding out the local names and the uses of these common weeds the present work has been undertaken.

COLLECTION AND OBSERVATION

The important and dominant weeds have been collected during their flowering seasons. The plants described in the list are arranged in the same order as in Haines's *Botany of Bihar and Orissa* for convenience. Most of these plants have been collected by the author with the help of Mr. N. K. Chayu Patnaik. They have been pressed and preserved in the Herbarium of the Botany Department of Ravenshaw College, Cuttack.

ENUMERATION OF PLANTS

MENISPERMACEAE

1. **Cocculus villosus** DC.

Local name	...	Dadaya (Or.)
Habit	...	A climber on hedges.
Flowers	...	November to April
Uses	...	The juice of the leaves mixed with water has the property of coagulating into a green jelly-like substance which is taken internally, sweetened with sugar. The roots and leaves are used in rheumatic pains.

2. **Cissampelos hexandra** Roxb.

Local name ... Akanamini (Or.)
Habit ... A lofty climber.
Flowers ... April to August.
Uses ... The root is used in fever, diarrhoea, urinary diseases, dyspepsia, etc.

PAPAVERACEAE

3. **Argemone mexicana** Linn.

Local name ... Agara or Kantakusuma (Or.)
Habit ... A prickly herb.
Flowers ... April to June.
Uses ... The oil from the seed is purgative, and the oil is also used in various kinds of skin diseases.

CAPPARIDACEAE

4. **Cleome viscosa** Linn.

Local name ... Chota anasorisa (Or.)
Habit ... A pubescent herb.
Flowers ... July to September.
Uses ... The juice of the leaves is locally poured into ear for ear-ache.

5. **Gynandropsis pentaphylla** DC.

Local name ... Anasorisa (Or.)
Habit ... A strong smelling weed.
Flowers ... July to September.
Uses ... Used as a substitute of *Cleome viscosa.*

VIOLACEAE

6. **Ionidium suffruticosum** Ging.

Local name ... Madan masta (Or.)
Habit ... Herb with pink flowers.
Flowers ... December to March.
Uses ... The leaves and tender stalks are demulcent.

CARYOPHYLLACEAE

7. **Polycarpaea corymbosa** Lamk.

Local name ... San Jatjatia (Or.)
Habit ... Erect herb.
Flowers ... August to November.
Uses ... Used locally as a remedy for the bites of venomous reptiles.

PORTULACACEAE

8. **Portulaca oleracea** Linn.

Local name ... Bada balbalua (Or.)
Habit ... A prostrate or erect, sub-succulent herb.
Flowers ... July to October.
Uses ... It is locally used as an article of diet in scurvy and liver diseases.

9. **Portulaca quadrifida** Linn.

Local name	...	Balbalua (Or.)
Habit	...	A prostrate, creeping and sub-succulent herb.
Flowers	...	July to October.
Uses	...	Same as in *P. oleracea.*

FICOIDEAE (AIZOCEAE)

10. **Mollugo spergula** Linn.

Local name	...	Pita sag (Or.)
Habit	...	A herb near ponds.
Flowers	...	February to April.
Uses	...	The juice is applied in itch and other skin diseases. The leaves are used as an article of diet.

11. **Trianthema monogyna** Linn.

Local name	...	Puruni (Or.)
Habit	...	A succulent herb.
Flowers	...	July to October.
Uses	...	The root is used as a medicine, generally in acute anaemic conditions.

MALVACEAE

12. **Abutilon indicum** G. Don

Local name	...	Pedipedica (Or.)
Habit	...	Annual shrub
Flowers	...	September to January.
Uses	...	Used in various diseases. The roots are useful in leucoderma.

13. **Sida cordifolia** Linn.

Local name	...	Bisiripi (Or.)
Habit	...	An erect undershrub.
Flowers	...	August to December.
Uses	...	The leaves and roots are said to have medicinal value ; leaves for healing sores.

14. **Sida veronicaefolia** Lamk.

Local name	...	Bajramuli (Or.)
Habit	...	A perennial herb.
Flowers	...	September to April.
Uses	...	The leaves are used as local application in cuts and bruises.

TILIACEAE

15. **Corchorus acutangulus** Lamk.

Local name	...	Bana-nalita (Or.)
Habit	...	An erect herb.
Flowers	...	September to November.
Uses	...	The dried leaves are used in dysentery.

EUPHORBIACEAE

16. **Croton sparsiflorus** Morung

Local name	...	Gandha tulasi (Or.)
Habit	...	A herb.
Flowers	...	May to September.
Uses	...	The latex is used in cuts and wounds.

17. **Euphorbia hirta** Linn. Syn. *E. pilulifera* (F.B.I.)

Local name	...	Chitakuti (Or.)
Habit	...	A herbaceous weed.
Flowers	...	All the year round.
Uses	...	The latex is applied locally in case of eye complaints. The plant, as a whole, is slightly stimulant and narcotic.

18. **Jatropha curcas** Linn.

Local name	...	Jahaji, Baigaba (Or.)
Habit	...	A large shrub.
Flowers	...	May to October.
Uses	...	Used as a hedge plant. The juice of the stem and leaves is applied to wounds.

19. **Phyllanthus niruri** Linn.

Local name	...	Badianla (Or.)
Habit	...	An erect annual herb.
Flowers	...	August to December.
Uses	...	Used in dysentery.

20. **Phyllanthus urinaria** Linn.

Local name	...	Bhuinanla (Or.)
Habit	...	A suffruticose annual.
Flowers	...	July to December.
Uses	...	Used in sleeplessness of children.

RHAMNACEAE

21. **Zizyphus jujuba** Lamk.

Local name	...	Barakoli (Or.)
Habit	...	A small tree or shrub.
Flowers	...	March to October.
Uses	...	Fruits are eaten when ripe and these make good jams. The bark and seeds are used for diarrhoea and the decoction of root for fever.

VITACEAE

22. **Vitis quadrangularis** Wall.

Local name	...	Hadavanga (Or.)
Habit	...	Sarmentose shrubs.
Flowers	...	July to October.
Uses	...	The upper part of the plant is used for bowel complaints and a poultice for broken bones.

23. **Vitis trifolia** Linn.

Local name	Amala-lata (Or.)
Habit	A herbaceous climber.
Flowers	April to September.
Uses	Seeds and roots are used for the treatment of yoke sores of bullocks.

24. **Vitis pedata** Vahl.

Local name	Guali lata (Or.)
Habit	A large climber.
Flowers	August to September.
Uses	This plant is used as domestic medicine, because of its astringency.

PAPILIONACEAE

25. **Clitoria ternatea** L.

Local name	Aparajita (Or.)
Habit	Twining herb.
Flowers	From October to December.
Uses	The roots and flowers have medicinal value. Used in urinay disorders.

26. **Crotolaria juncea** Linn.

Local name	Chanapata (Or.)
Habit	A stout shrub.
Flowers	August to January. Yellow.
Uses	Yields fibre and used as green manure.

CAESALPINACEAE

27. **Cassia occidentalis** Linn.

Local name	Chakunda (Or.)
Habit	An undershrub.
Flowers	August to October.
Uses	Roots, seeds and leaves are known to be purgative, and are also useful in cough and whooping cough. The plant is also used for skin diseases.

MIMOSACEAE

28. **Mimosa pudica** Linn.

Local name	Lajkuli (Or.)
Habit	Prickly shrub.
Flowers	July to March.
Uses	The leaves and roots are used for piles and fistula.

CUCURBITACEAE

29. **Cephalandra indica** Nand.

Local name	Kainchikakudi (Or.)
Habit	A climbing herb.

Flowers	August to December.
Uses	The leaves mixed with butter are applied as a liniment to sores. The roots have also medicinal value.

UMBELLIFERAE

30. **Hydrocotyle asiatica** Linn.

Local name	Thallkudi (Or.)
Habit	A herb with long creeping stems.
Flowers	November to January.
Uses	It is useful as a tonic in diseases of skin, nervous system and blood.

RUBIACEAE

31. **Oldenlandia corymbosa** Linn.

Local name	Ghar-podia (Or.)
Habit	A diffuse annual herb.
Flowers	June to January.
Uses	It is used in jaundice, liver complaints, and chronic malaria.

32. **Spermacoce hispida** Linn.

Local name	Sana ghar-podia (Or.)
Habit	Procumbent herb.
Flowers	October to December.
Uses	The roots and seeds have medicinal value.

COMPOSITAE

33. **Blumea lacera** DC.

Local name	Pokasunga (Or.)
Habit	A hairy herb.
Flowers	October to March.
Uses	The expressed juice of the leaves is a useful anthelmintic. It is used in cases of thread-worm.

34. **Eclipta alba** (Linn.) Hassk.

Local name	Kesadura (Or.)
Habit	A slender herbaceous weed.
Flowers	August to February.
Uses	The boiled decoction of the root is drunk as a purgative and emetic. It is also used in various skin diseases, specially leprosy, chronic skin diseases, and ring-worm. The leaves and flowers are also used in tooth-ache. The juice of the leaves is used as a hair tonic.

35. **Enhydra fluctuans** Lour.

Local name	Hidimichi (Or.)
Habit	A prostrate herb.

Flowers ... December to January.
Uses ... Used as a vegetable and laxative. It is claimed to be useful in diseases of skin and nervous system.

36. **Gnaphalium indicum** Linn.

Local name ... Naka-chunkuni (Or.)
Habit ... Hoary or woolly herb.
Flowers ... March to July.
Uses ... The leaves have medicinal value.

37. **Grangea maderaspatana** Poir.

Local name ... Agnikumari (Or.)
Habit ... A procumbent weed.
Flowers ... December to May.
Uses ... The leaves are regarded as valuable stomachic.

38. **Tridax procumbens** Linn.

Local name ... Bisalyakarani (Or.)
Habit ... Herb.
Flowers ... November to June.
Uses ... The stem, leaves, and roots are used in case of wound and cuts.

39. **Vernonia cinerea** Less.

Local name ... Pokasunga (Or.)
Habit ... An annual herb.
Flowers ... August to April.
Uses ... A poultice of leaves is applied to the head for headache. Bruised leaves are applied for ring-worm by some people.

40. **Xanthium strumarium** Linn.

Local name ... Bana gokhara (Or.)
Habit ... An erect herb.
Flowers ... November to February.
Uses ... It has proved useful in urinary diseases.

Apocynaceae

41. **Vinca rosea** Linn.

Local name ... Sada-behari (Or.)
Habit ... A herb.
Flowers ... All the year round.
Uses ... The juice of the leaves and flowers is used as an application for wasp stings.

Asclepiadaceae

42. **Calotropis gigantea** R. Br.

Local name ... Arka (Or.)
Habit ... A stout shrub.

Flowers ...	December to July.
Uses ...	The latex is locally used for wounds and tooth troubles. The leaves are also used for fomentation for the diseases of the chest.

GENTIANACEAE

43. **Canscora diffusa** Br.

Local name ...	Banbana (Or.)
Habit ...	A herb.
Flowers ...	All the year.
Uses ...	The plant is used as a laxative.

BORAGINACEAE

44. **Heliotropium indicum** Linn.

Local name ...	Hatisundha (Or.)
Habit ...	A small herb.
Flowers ...	October to May.
Uses ...	The plant is locally used as application for boils, sores and stings of insects.

CONVOLVULACEAE

45. **Cuscuta reflexa** Roxb.

Local name ...	Nirmuli (Or.)
Habit ...	A leafless twining parasite.
Flowers ...	October to December.
Uses ...	Seeds are regarded as carminative.

46. **Evolvulus alsinoides** Linn.

Local name ...	Bichhamalia (Or.)
Habit ...	A much branched diffused perennial herb.
Flowers ...	July to December.
Uses ...	The leaves and roots are used in dysentery.

SOLANACEAE

47. **Datura fastuosa** Linn.

Local name ...	Dudura (Or.)
Habit ...	A small shrubby plant.
Flowers ...	July to November.
Uses ...	The leaves, seeds, and roots are used in medicine. The leaves and roots are smoked in asthma.

48. **Nicotiana plumbaginifolia** Viv.

Local name ...	Hemaraj (Or.)
Habit ...	Annual herb.
Flowers ...	February to March.
Uses ...	The leaves have medicinal value.

49. **Solanum nigrum** Linn.

Local name ... Nununuria (Or.)
Habit ... Gregarious herb.
Flowers ... Most of the year
Uses ... The berries and the juice are said to have laxative and diuretic properties.

50. **Solanum xanthocarpum** Schrad. & Wendl.

Local name ... Ankaranti (Or.)
Habit ... A prostrate prickly herb.
Flowers ... December to June.
Uses ... Fruits and roots are used in medicine. Root is used in cough, asthma, and catarrh. Root is locally used as a preventive against small-pox.

Scrophulariaceae

51. **Herpestis monniera** H. B. & K.

Local name ... Brahmi (Or.)
Habit ... A creeping sub-succulent herb.
Flowers ... August to February.
Uses ... Used as brain tonic.

Acanthaceae

52. **Andrographis paniculata** Nees.

Local name ... Bhuinimba (Or.)
Habit ... A herbaceous weed.
Flowers ... March to August.
Uses ... It has reputation as a bitter tonic in dysentery. It is also used as substitute and sometimes adulterant of chiretta (*Swertia chireta* Buch.-Ham.)

53. **Asteracantha longifolia** Nees. Syn. *Hygrophila spinosa* T. Anders.

Local name ... Koilikhia (Or.)
Habit ... A robust spiny herb.
Flowers ... October to December.
Uses ... The leaves and roots have medicinal value.

54. **Barleria prionitis** Linn.

Local name ... Daskeranta (Or.)
Habit ... A prickly shrub.
Flowers ... April.
Uses ... It is used in medicine for various diseases. It is locally used as hair tonic.

55. **Adhatoda vasica** Nees

Local name ... Basanga (Or.)
Habit ... A tall shrub.
Flowers ... February to March.
Uses ... The juice mixed with ginger is used as a remedy for cough.

VERBENACEAE

56. **Clerodendrum inerme** Gaertn.

Local name ... Genguti (Or.)
Habit ... A straggling shrub.
Flowers ... December to April.
Uses ... It has reputation as a febrifuge.

57. **Lantana camara** Linn. var. **aculeata** Mold.

Local name ... Naga-airi (Or.)
Habit ... A straggling shrub with small prickles.
Flowers ... All the year round.
Uses ... Leaves are used to relieve indigestion.

58. **Vitex negundo** Linn.

Local name ... Begunia (Or).
Habit ... A shrub
Flowers ... Most of the year.
Uses ... The roots and leaves are regarded as tonic and febrifuge. The decoction of the leaves is given in headache and catarrh.

LABIATAE

59. **Anisomeles ovata** Br.

Local name ... Bhutamari (Or.)
Habit ... A strong smelling annual herb.
Flowers ... September to November.
Uses ... The plant is used in medicine as carminative, astringent, and as tonic.

60. **Leucas aspera** Spreng.

Local name ... Gaisa (Or.)
Habit ... An annual herb.
Flowers ... September to January.
Uses ... The juice of the leaves is applied in chronic skin diseases.

61. **Ocimum basilicum** Linn.

Local name ... Sugandha (Or.)
Habit ... An aromatic herb.
Flowers ... September to December
Uses ... The seeds and leaves are used as medicine. The juice of the leaves mixed with ginger and black pepper is given in cold and fever.

62. **Ocimum sanctum** Linn.

Local name ... Tulasi (Or.)
Habit ... An undershrub and sometimes cultivated.
Flowers ... October to February.
Uses ... The leaves are used in cough, cold, and bronchitis. The preparation is applied to skin in ring worm.

Nyctaginaceae

63. **Boerhaavia diffusa** Linn.

Local name ... Ghodapuruni (Or.)
Habit ... A diffuse herb.
Flowers ... August to November.
Uses ... Used locally in jaundice.

Amaranthaceae

64. **Achyranthes aspera** Linn.

Local name ... Apamaranga (Or.)
Habit ... A herbaceous plant.
Flowers ... October to January.
Uses ... It has got a reputation as medicinal plant.

65. **Alternanthera sessilis** Br.

Local name ... Madaranga (Or.)
Habit ... A prostrate herb.
Flowers ... July to January.
Uses ... Used as a vegetable. Also medicinally in dysentery and liver disorders.

66. **Amaranthus spinosus** L. Ridley

Local name ... Kantaneutia (Or.)
Habit ... A prickly herb and a common weed.
Flowers ... Throughout the whole year.
Uses ... The leaves are used as spinach. It is claimed to be a good cattle fodder which increases milk. The roots are used externally for curing inflamed wounds and for ripening boils.

67. **Aerua lanata** Juss.

Local name ... Paunsia (Or.)
Habit ... A perennial weed.
Flowers ... November to January.
Uses ... The flowering tops and roots are used in the treatment of head-ache.

68. **Celosia argentea** Linn.

Local name ... Ganjachulia (Or.)
Habit ... A glabrous erect annual herb.
Flowers ... August to December.
Uses ... Seeds are used in diarrhoea.

Polygonaceae

69. **Polygonum plebejum** Br.

Local name ... Muthi saga (Or.)
Habit ... A diffusely branched prostrate herb.
Flowers ... February to May.
Uses ... Used as a vegetable and the root is very useful astringent.

Araceae

70. **Amorphophallus campanulatus** Blume

Local name ... Olua (Or.)
Habit ... A stout herb with a single aerial leaf.
Flowers ... November to February.
Uses ... The corm is used as a vegetable. It is used in medicine for dysentery.

71. **Pistia stratiotes** Linn.

Local name ... Borajhanji (Or.)
Habit ... A floating weed.
Flowers ... February to May.
Uses ... The plant is cooling and demulcent.

Cyperaceae

72. **Cyperus rotundus** Linn.

Local name ... Mutha (Or.)
Habit ... A weed of gardens and waste grounds having small black tubers.
Flowers ... July to December.
Uses ... The rhizomes are used in medicine in stomach troubles and dysentery.

Gramineae

73. **Cynodon dactylon** Pers.

Local name ... Duba (Or.)
Habit ... A trailing herb (runner).
Flowers ... Most of the year.
Uses ... It is good fodder for cattle. The bruised grass is applied to wounds or cuts to stop bleeding.

Commelinaceae

74. **Commelina benghalensis** Linn.

Local name ... Kanasiri (Or.)
Habit ... A sub-succulent creeping herb.
Flowers ... July to November.
Uses ... Used as a vegetable and a good fodder. It is said to have medicinal value.

Discussion

This is preliminary work and the investigation of the flora of Orissa is in progress. Weeds are not always undesirables. Though these plants disturb the growth of the cultivated plants, they are of use in some way or other. Plants almost universally considered troublesome become of great value under special circumstances. We have got a vast wealth and variety of plants which grow under natural conditions in waste places, ditches, ponds, river banks and forests. Most of these plants are used even to-day as folk-medicine. Vegetable drugs have been known all over the world for centuries. Medicinal plants are mostly used in crude form locally. Families like Malvaceae, Euphorbiaceae, Vitaceae, Compositae, Solanaceae, Acanthaceae, Verbenaceae, Labiatae and Amaranthaceae have a large number of useful weeds in this locality.

SUMMARY

Preliminary work has been done to find out the useful weeds of Cuttack and its neighbourhood. Most of the weeds are found to be useful in some way or other Some of these plants have high medicinal value. The detailed investigation is still in progress.

ACKNOWLEDGEMENTS

This is a part of the work done in connection with the Botanical Survey of Orissa entrusted to Prof. B. Samantarai by the Board of Scientific and Industrial Research, Orissa. My thanks are due to the said Board for financial help, and to Prof. B. Samantarai for kind supervision and encouragement. I am also grateful to Mr. C. M. Bastia of this Department for his encouragement.

REFERENCES

1. Bal, S. N. (1942) : Useful plants of Mayurbhanj State in Orissa. *Records Bot. Surv. India*, **6** : 1–118.
2. Haines, H. H. (1925) : The Botany of Bihar and Orissa, parts 1–6, London.
3. Mooney, H. F. (1950) : Supplement to the Botany of Bihar and Orissa. Ranchi.
4. Prain, D. (1903) : Bengal Plants. Vols. I and II. London.

NOTES ON THE HETEROCERA OF CALCUTTA

BY

D. G. SEVASTOPULO, F.R.E.S.

PART III

(*Continued from Vol.* 53 (4), p. 658)

The present part includes the families Uraniidae, Epiplemidae and Geometridae. The first two are both very small groups and the third, in my experience, is very poorly represented in the plains of India. The treatment is on similar lines to previous parts.

URANIIDAE

Micronia aculeata Guen.—One at light, unfortunately I have no record of the date of capture.

EPIPLEMIDAE

Dirades theclata Guen.—Fairly common. Records for vi and x. Now *D. adjutaria* Wlk.; *D. theclata* is the African species.

GEOMETRIDAE

OENOCHROMINAE (Hampson's ORTHOSTIXINAE)

Eumelea ludovicata Guen.—Uncommon. Records for x and xi. The Fauna treats it as a synonym of *rosalia* Guen.

Ozola microniaria Wlk.—One in x.

HEMITHEINAE (Hampson's GEOMETRINAE)

Pseudoterpna ruginaria Guen.—A single specimen bred in iv. Larva on *Nephelium litchi.* Now *Pingasa.*

Agathia lycaenaria Koll.—Imagines not common. Records for i, ii, viii, x, xi and xii. Larvae common on Oleander and I have not been able to find any distinguishing character to separate them from the larvae of the next species.

A. laetata F.—Imagines common. Recorded in iii, x, xi and xii. Larvae common on Oleander.

Uliocnemis cassidara Guen.—Common. Records for i, ii, iii, vii, x, xi and xii. Larvae reared *ab ovo* fed on *Zizyphus jujuba* (Rhamnaceae), *Lagerstroemia indica* (Lythraceae) and *Ixora* sp. (Rubiaceae). Now *Comibaena.*

Lophomachia picturata Hamps.—Uncommon. Recorded in x and xi. Not in the Fauna.

Euchloris quantula Swinh.—One f. *glareosa* Swinh. in x. Now *Chloeres.*

Comostola confusa Warr.—Rare. Records for i and xii. Not in the Fauna.

Euchloris subtiliaria Brem.—Common. Records for i, vi, x and xi. Now *Comostola laesaria* Wlk.; *E. subtiliaria* not occurring in India.

Nemoria indecretata Wlk.—Common. Recorded in vi and vii. Now *Microloxia.*

Thalassodes quadraria Guen.—Common. Records for iii, iv, vi, vii, ix, x, xi and xii. Larvae on *Polyalthia longifolia* (Anonaceae).

T. veraria Guen.—Likewise common. Records for i, iii, vi to ix, xi and xii. One larva found on cultivated Chrysanthemum.

Gelasma goniaria Feld.—One in i. The *Thalassodes acutissima* Wlk. of the Fauna, but this is really another species.

Thalassodes rubrolimbraria Guen.—One in xii. Now *Pamphlebia.*

T. avicularia Guen.—One in viii. Now *Ornithospila.*

Hemithea costipunctata Moore—Uncommon. Recorded in xi only. Treated in the Fauna as a synonym of *Thalera caudularia* Guen.

Thalera chrysolineata Wlk.—Uncommon. Records for ii and iii. Now *Berta.*

STERRHINAE (Hampson's ACIDALIINAE)

Ptochophyle togata F.—Common. Recorded in i, ii, vi and ix to xii. The Fauna does not distinguish this species from *permutans* Hamps. Larvae on *Eugenia jambolana* (Myrtaceae).

Somatina anthophilata Guen.—One in i.

Trigodes cuneilinea Wlk.—One in x. Now *Antitrygodes.*

Craspedia emissaria Wlk.—Common. Records for i, ii and vii to xii. Larvae on *Aeschynomene indica* (Leguminosae). This, and all the following *Craspedia* species, are now included in *Scopula.*

C. cleoraria Wlk.—Very common. Records for i to iii and ix to xii. Larvae on a cultivated Lantana (Verbenaceae). The Fauna treats this as a synonym of *fibulata* Guen., from which it is distinct.

C. opicata F.—Common. Records for x only.

C. nictata Guen.—Common. Records for iii, vi, vii and ix to xii.

C. remotata Guen.—Common. Records for i, iii and x to xii. My specimens agree with the figure in the Fauna, but Hampson has lumped a number of species together.

Sterrha macrospila Prout—Common. Records for i, v to vii, ix, xi and xii. Not in the Fauna.

Sterrha sacraria L.—One in vi. Now *Rhodometra.* The Fauna includes it in the Larentiinae.

LARENTIINAE

The only example of this sub-family is an unidentified *Chloroclystis* which I bred fairly commonly.

ENNOMINAE (Hampson's BOARMINAE)

Scardamia metallaria Guen.—Rare. Records for vii only.

Prionia squalidaria Hbn.—Rare. Records for i, iii, vii, x and xi. Now *Osicerda.*

Macaria fasciata F.—Fairly common. Recorded in viii. Now *Semiothisa.*

M. frugaliata Guen.—Fairly common. Records for ii, vi, xi and xii. Now *Semiothisa.*

Tephrina disputaria Guen.—One in viii.

Orsonoba clelia Cr.—One in vii.

Hyposidra talaca Wlk.—Fairly common. Recorded in i and ii. Larvae on Castor.

Dilinia medardaria Herr. Schaff.—A single specimen bred in xi. Larva on *Zizyphus jujuba.*

Hyperythra lutea Cr.—Not uncommon. Records for iii and x.

Biston suppressaria Guen.—Common, also larvae. Records for all months except vii, ix and xii. Larvae on *Cassia fistula*, *Lagerstroemia indica* and *Carissa carandas* (Apocynaceae).

Boarmia sublavaria Guen.—Common. Records for iv, vi to x and xii.

A disappointing list; a Mercury Vapour lamp would, I feel sure, have produced considerably more, both species and individuals.

(*To be continued*)

SOME BENEFICIAL COCCINELLIDS OF MYSORE

BY

M. PUTTARUDRIAH AND G. P. CHANNA BASAVANNA
Division of Entomology, Department of Agriculture, Bangalore

This list pertains to the further collections made and hosts noted subsequent to those reported by us (1953 and 1955), and is prepared on the same basis as the previous ones. It includes 25 species belonging to 8 tribes, the tribe Scymnini being numerically well represented. Most of the species included here were determined by Dr. R. D. Pope of the British Museum, London, as also the synonymy of *Menochilus* 6-*maculatus* (Fabr.). The identification of *Scymnus* (=*Pullus*) *quadrillum* Motsch. and *Scymnus nubilus* Muls. was confirmed by Dr. A. P. Kapur of the Zoological Survey of India, Calcutta. The mite species mentioned here were determined by Dr. A. Earl Pritchard of the University of California. We are grateful to them.

SCYMNINI

Pullus nubilus Muls. This species was reported by us (1953) under the name *Scymnus nubilus* Muls. as feeding on aphids infesting groundnut, cowpea, jowar, *Phaseolus mungo* and cotton. It has since been found feeding on two more species of aphids, *Aphis nerii* Fonsc. and *Rhopalosiphum nympaeae* (L.), and the brinjal mealybug, *Phenacoccus insolitus* Green. The predator was found active on the above hosts from January to May.

Chatterjee and Bose (1934) have recorded the species from various places in South India as occurring throughout the year but abundant during July and August.

Pullus picescens Gorh. The species was found feeding on the aphid *Rhopalosiphum nymphaeae* infesting *Trapa*, an aquatic plant, during January 1954. Both young ones and adults were found together on aphid-infested *Trapa* plants.

There appears to be no record of the species in India.

Pullus victoris Motsch. A variety of this species was reported by us (1955) as feeding on *Pseudococcus* sp. infesting *Boehmeria* plant. The species was found breeding extensively on aphid-infested (*A. nerii*) plants of *Calotropis* during March-May 1954 round about Bangalore.

Pullus castaneus Sic. The species was previously recorded by us (1955) as feeding on *Aphis maidis* Fitch, and has been since found feeding on the cotton-aphid *Aphis gossypii* Glov. during April 1954 around Bangalore.

Pullus gratiosus Weise var. The beetles of the species were bred from the fluted scale, *Icerya purchasi* Mask. infesting Casuarina around Mandya (Mysore) during May 1954. This was previously found by us (1955) feeding on *Pseudococcus* sp. infesting *Boehmeria.*

Scymnus (=Pullus) quadrillum Motsch. When this was last recorded by us (1953) the specific determination was doubtful. The determination has since been confirmed by Dr. A. P. Kapur. The predator has also been found feeding on the cotton aphid *A. gossypii*, and aphids infesting brinjal around Bangalore.

Scymnus sp. ? **guimeti** Muls. Since last reporting (1955) this species on aphid-infested cotton plants around Bangalore, the species has been found on the potato-aphid *Aphis malvoides* Das and on *A. nerii*, infesting *Calotropis* plants during February to April 1954.

Scymnus sp. This undetermined species was bred from the aphid, *A. malvoides*, infesting potato plants around Bangalore during February 1954.

Nephus regularis Sic. The species was found abundantly in the larval and adult stages on mealybug, *Pseudococcus* sp., infesting *Boehmeria* plants together with another coccinellid *P. victoris*, during April 1954, and also to a lesser extent on *Pseudococcus*-infested *Glyricidia* and guava plants.

Stethorus gilvifrons (Muls.) The species was found feeding on the red spider mite (*Tetranychus* sp.) infesting papaya plants around Bangalore during January to March 1954. Larvae and adults were seen in large numbers on the lower surface of leaves particularly on those that were heavily infested with mites.

The species has so far been recorded only from North India (Kapur, 1948) as feeding upon mites infesting apple tree and castor.

Stethorus tetranychi Kapur. The adults of the species, which have very close resemblance to *S. gilvifrons*, were found feeding on red mites, *Raoiella indica* (Hirst), infesting areca palms round about Tharikere (Mysore) during April 1954, and also on *Tetranychus* sp. infesting papaya leaves at Hebbal (Bangalore) during August 1953.

Stethorus sp. nr. **pauperculus** Weise. *Stethorus pauperculus* Wse. has been recorded by us (1953) as feeding on sorghum-mite, *Paratetranychus indicus* Hirst. Adult specimens, which have been identified as *Stethorus* sp. nr. *pauperculus*, have been found feeding on mites, *Eutetranychus banksi* (McG.), infesting castor around Bangalore during April 1954. Both grubs and adults were seen amongst the mite population on the lower surface of leaves

Stethorus parcepunctatus Kapur. The beetles of this species were collected from mite (*R. indica*)-infested areca palms around Tharikere (Mysore) during April 1954.

The species has been described by Kapur (1948) as a new one from material from Kanara (India) without record of any host.

ASPIDIMERINI

Pseudaspidimerus circumflexa (Motsch.) var. **testaceus** (Weise). The predator has been found to be active almost throughout the year and feeding on several species of aphids. The following are the additional aphid-hosts which have not been included in our previous records (1953, 1955):

A. gossypii, infesting *Psidium guava* during November 1953; *Aphis rumicis* Linn., infesting cowpea during January 1954; *Aphis medicaginis*

Koch., infesting *Dolichos lablab ; A. nerii* infesting *Calotropis gigantca ; A. malvoides* infesting potato, and aphids infesting brinjal. It has also been found to feed on the mealybug, *Pseudococcus* sp., infesting *Boehmeria* plants.

HYPERASPINI

Hyperaspis maindroni Sic. Since our last record (1955) of the species as feeding on *Pseudococcus* sp. infesting *Boehmeria* plants, it has been found feeding on *A. gossypii* on cotton. Only adults were found on aphid-infested plants during October 1954 round about Bangalore. It was also collected from *Pseudococcus*-infested *Boehmeria* plants during the above month.

Hyperaspis maindroni Sic. var. **brumoides** Sic. This variety was found together with the above species on aphid-infested cotton plants around Bangalore. A large number of adults were also bred from *Pseudococcus*-infested cotton plants received from Hiriyur (Mysore) during January 1954. Both adults and larvae of the predator were seen actively feeding on young ones of the mealybug, and appeared to have good controlling influence on the mealybug infestation.

PHARINI

Sticholotis cribrellata Fairm. Larvae of this species were found feeding on an undetermined scale infesting the nodal regions of bamboo twigs, and usually covered by sheaths at Hebbal (Bangalore). This was reported by us (1955) as *Sticholotis* sp. nr. *cribrellata* feeding on the same species of scale, and there appears to be no other record of this in India.

Sticholotis sp. This unidentified species is quite distinct from the other species of *Sticholotis* in our collection and was collected from *Pongamia* galls during April (1954). Host is not known. The beetle is smaller in size than the other species of the same genus so far recorded by us, and with the elytra shining dark and the pronotum and head paler.

CLANINI

Juaravia (= Clanis) pallidula Motsch. Subsequent to our previous record (1955) the species has been collected from *Pongamia* twigs infested with an undetermined mealybug during April 1954 around Bangalore.

Juaravia soror (Weise). This common species of the genus was collected on areca palms infested with mites, *R. indica*, around Tharikere (Mysore) during April 1954. Only adults could be seen during the time of collection. This was last reported by us (1955) on mealybugs, infesting sandal trees.

COELOPTERINI

Pharoscymnus horni (Weise). The adults have been collected from mealybug (*Saccharicoccus sacchari* Ckll.)-infested sugarcane around Mandya (Mysore). The species has also been noted to be quite abundant on *Thevetia* plants infested with hard scale, and cactus infested with *Diaspis echinocacti* (Bouché) during January–June 1954, and more particularly on cactus.

The species has been identified by Dr. A. P. Kapur as *P. horni*, whereas the specimens from the same lot and others appearing same have been put as *Pharoscymnus guimeti* (Muls.) by Dr. R. D. Pope of the British Museum, London. However, the name given by the former has been followed here as it is the correct name for the species.

CHILOCHORINI

Brumus suturalis. This fairly common species, which has been recorded by various workers as feeding on a variety of hosts, like mites, psyllids, aleyrodids, aphids, and coccids, was found in good numbers feeding on *A. nerii* infesting *C. gigantea* around Bangalore during May 1954. Only adults were found during this period.

COCCINELLINI

Coccinella arcuata Fabr. A variety of this species (var. *octomaculata*) was recorded by us (1953) as feeding on *A. rumicis*, infesting cowpea. The species has since been found in a paddy field near Bangalore. The beetles might have been feeding on aphids found here and there on paddy in the field.

Coelophora sp. This species, which differs from the other species of the genus in our collection, has been found feeding on *Asterolecanium* sp. nr. *fusum* Russel infesting bamboo at Hebbal (Bangalore) during October 1953.

Menochilus 6-maculatus (Fabr.) Since the previous record by us (1955) from Malavalli (Mysore) the species has been collected from cowpea plants infested with *A. rumicis* and on *Calotropis* plants infested with *A. nerii* during April 1954.

Two colour forms have been found together on both these hosts. In one, the elytra are entirely yellowish brown excepting for a very thin, black line along the anal margin of each elytron ; and these narrow black margins form a single narrow black streak along the mid-longitudinal line when the elytra are held together over the body. In another form, each elytron bears a zigzag yellowish-red marking which together form a zigzag cross bar on the elytra when the wings are held together. The rest of the elytra is shining black. The colour pattern of the pronotum is the same in the two series. *Menochilus* 6-*maculatus* (Fabr.) is synonymous with *Chilomenes* 6-*maculatus* (Fabr.) reported in our earlier paper (1953), and the former is the valid name of the species. In addition to the above two colour forms, there are two more principal types of colour patterns in the species in our collection. In one, the beetles show the typical three black markings on each elytron, and in the other type, elytra are entirely shining black with at most a thin paler costal margin in some specimens.

REFERENCES

Chatterjee, N. C. and Bose, M. (1934) : *Ind. Forest Rec.*, **19** (7) : 1–10.

Kapur, A. P. (1948) : *Bull. ent. Res.*, **39** (2) : 297–320.

Puttarudriah, M. and Channa Basavanna, G. P. (1953) : *Ind. J. Ent.* **15** (2) : 87-96.

Puttarudriah, M. and Channa Basavanna, G. P. (1955) : *Ind. J. Ent.*, **17** (1) : 1–5.

FURTHER OBSERVATIONS ON THE BIOLOGY OF THE COMMON 'TREE-HOPPER' *OTINOTUS ONERATUS* WALK. (HOMOPTERA, MEMBRACIDAE) IN ORISSA

BY

UPENDRA CHANDRA PANDA
Fakir Mohan College, Balasore

AND

BASANTA KUMAR BEHURA
Ravenshaw College, Cuttack

SYNOPSIS

Fifteen new host-plants of the membracid *Otinotus oneratus* Walk. are recorded. It infests woody plants during winter and summer. The eggs are laid in parallel rows, each row consisting of 6 to 15 eggs. *O. oneratus* is found all the year round, but is most abundant during the rains and autumn. It takes about a month and a half for its development from egg to adult. The adults sit with their head pointed downward, upward, or towards the base of the branch. They are most active during the hot parts of the day. During mating, the male and female point in opposite directions and copulation lasts about an hour or less. The nymphs and adults are attended by the ant *Camponotus* (*Tanaemyrmex*) *compressus* Latr. The adults of *O. oneratus* are parasitised by a species of *Indoxenos* (Strepsiptera).

INTRODUCTION

Otinotus oneratus Walk. is one of the most widely distributed membracids of India, occurring in Ceylon as well (Distant, 1908, 1916; Behura, 1951; Behura and Sinha, 1951). One of us (Behura, 1951) recorded observations on the habits of *O. oneratus*. The present paper embodies further observations made at Balasore and Cuttack during 1952 to 1955.

HOST-PLANTS

It has already been recorded (Behura, 1951) that the membracid feeds and breeds on fifteen species of host-plants in Orissa. In the present paper, the same is confirmed and an additional fifteen host-plants are recorded from Orissa (Table No. 1.).

In Balasore, the most preferred food-plant of *O. oneratus* is *Datura fastuosa* on which all the stages of the membracid are found in large numbers in August. The plants next in preference are *Cajanus indicus, Cassia fistula* and *Albizzia lebbeck*. During winter and summer, the insects are found in lesser numbers and usually abound on woody plants like *Zizyphus jujuba, Zizyphus oenoplia, Calophyllum inophyllum* and *Bauhinia variegata*. In the gardens of the city of Cuttack, TABLE No. 1.

Hitherto unrecorded host-plants of *Otinotus oneratus* Walk. in Orissa

No.	Scientific name of the plant	Family	Local popular name current in Orissa	Locality	Period of infestation as observed by the authors
1.	*Holarrhena antidysenterica* ...	Apocyanaceae.	Koruan.	Kalyanpur (Athmallick).	July.
2.	*Hydnocarpus kurzii* ...	Bixaceae.	Chalmugura.	Khurda.	May.
3.	*Bauhinia variegata* ...	Caesalpiniaceae.	Kanchana.	Balasore.	February.
4.	*Cassia fistula* ...	Caesalpiniaceae.	Sonari.	Balasore.	July-October.
5.	*Cosmos bipinnatus* ...	Compositae.	(Cosmos).	Balasore.	October.
6.	*Calophyllum inophyllum* ...	Guttiferae.	Polanga.	Nardia (Cuttack Dist.).	July.
7.	*Althaea rosea* ...	Malvaceae.	(Hollyhock).	Balasore.	March.
8.	*Albizzia lebbeck* ...	Mimosae.	Sirisha.	Nardia (Cuttack Dist.).	July.
	Pithecolobium dulce ...	Mimosae.	Belati Kaiyan.	Cuttack.	July.
10.	*Artocarpus integrifolia* ...	Moraceae.	Panasha.	Sudhakanthy (Cuttack Dist.).	August.
11.	*Eucalyptus* sp. ...	Myrtaceae.	(Eucalyptus).	Balasore.	January.
12.	*Eugenia jambolana* ...	Myrtaceae.	Jamu.	Cuttack.	July.
13.	*Eugenia malaccensis* ...	Myrtaceae.	Jamurol.	Balasore and Cuttack.	July.
14.	*Sesbania aculeata* ...	Papilionaceae.	Dhanicha.	Cuttack.	May-September.
15.	*Sesbania grandiflora* ...	Papilionaceae.	Agasti.	Balasore.	July-February.

however, *O. oneratus is* most abundant on *Inga dulcis* and *Sesbania aculeata.*

EGG-LAYING

The eggs are laid in parallel rows under the soft bark of host-plants. They are embedded vertically and in a slightly inclined fashion. The number of eggs found in each row varies from 6 to 15. They are whitish when laid and gradually turn pink and finally black before hatching. The eggs are laid at all seasons, but in the largest numbers during the rains and autumn.

SEASONAL OCCURRENCE

O. oneratus is seen all the year round. In Balasore, they are most common during June to October. The development from the egg to the adult of the membracid on the host-plant *Cajanus indicus* at Balasore during January and February 1954 was found to take about a month and a half, during which five instars were observed.

HABITS

O. oneratus is gregarious in nature. The adults and nymphs are found crowded in the nodal and apical parts of the young shoots and on the lower side of the midribs of the bigger leaves. They rest motionless on the host-plants for hours together engaged in sucking the sap. The adults sit with their heads pointed upward downward or towards the base of the branch.

Both the adults and nymphs are very active during the hot parts of the day. They take to the wings on the slightest provocation on clear sunny days, while on a rainy or cloudy day they crawl round the twig and fly away only when much disturbed.

MATING

The mating activity begins from about 10 o'clock in the day. The male crawls over the female so that their caudal extremities meet. Sometimes two or three males are found to crowd on the back and sides of a single female. In copulation, the aedeagus of the male is inserted into the female gonopore, the claspers of the former aiding in grasping the latter's body. Then the head and body of the male are moved through an angle of 180° so that the copulating pair face in opposite directions. Copulation lasts about an hour or less. The hooked nature of the aedeagus prevents quick separation of the pair *in copula,* and when disturbed the female keeps on dragging the male behind her or the pair falls to the ground without being separated. Finally, the male again moves to his original position and withdraws the aedeagus effecting a separation.

ATTENDANCE BY ANTS

In all the host-plants, *O. oneratus* is usually attended by the common black ant *Camponotus (Tanaemyrmex) compressus* Latr.

The ants keep on moving constantly on the twigs and leaves infested by the nymphs and adults and guard the ant-cattle against any unwelcome intruder. The honeytubes of the nymphs are often kept raised. The ants lick the drops of honey from the tips of the honeytubes as they move among the drove. The adults sometimes ward off the ants by moving their bodies sideways, when the latter coax them for more honey. On transferring some live nymphs and adults of *O. oneratus* to some isolated pot plants at Balasore, the ants were found to begin their march to the unattended membracids within a few hours.

PARASITES

Both at Cuttack and at Balasore, the adults of *O. oneratus* were found to be parasitized by a Strepsipteran, a species of *Indoxenos*. The number of parasites collected between October and February 1953-54 at Balasore were, on female hosts—1, 1, 1, 1, 2, 2; and on male hosts—1, 1, 1, 2, 3, 3, 3. Thus the maximum number of parasites collected from a single individual was three. The proportion of sexes in the parasites differed, the number of females being greater than males. The present parasite differs in some respects from *Indoxenos membraciphaga* Sub. bred from *O. pallescens* (Syn: *O. oneratus*) in Mysore (Subramaniam, 1927) and may prove to be a new species.

Parasitization by the Strepsipteran appeared to be not fatal to the host, as some live specimens of *O. oneratus* collected in the field showed that the parasites had already escaped from their bodies, although apparently the latter were leading a normal life. The parasitized membracids are characterised by a nodular growth at the side of the abdomen.

ACKNOWLEDGEMENTS

Sincere thanks are due to Sri C. M. Bastia and Sri H. Patnaik of the Departments of Botany, Ravenshaw College, Cuttack, and to Sri P. C. Sinha, Department of Biology, Gangadhar Meher College, Sambalpur, for their kind help in the determination of the host-plants recorded in the paper. We also record our gratefulness to Prof. P. N. Ganapati, Professor of Zoology, Andhra University, for his kind help in the preparation of the manuscript.

REFERENCES

Behura, B. K. (1951): Habits of the common membracid ('Tree-hopper') *Otinotus oneratus* Walk. (Homoptera: Rhynchota), *JBNHS,* **50** (2): 294-304.

— — — and Sinha, H. (1951): A record of the common membracid, *Otinotus oneratus* Walk. (Homoptera: Rhynchota) from the city of Patna (Bihar)—ibid. **50** (1): 183-184.

Distant, W. L. (1908): The Fauna of British India, Rhynchota. **4**: 40-41.

— — — (1916): ibid. **6**: 160.

Subramaniam, T. V. (1927): A new genus and species of the Strepsiptera from South India, *Indoxenos membraciphaga* gen. and sp. nov.—*Trans. Ent. Soc. Lond.* **75**: 131-135.

REVIEWS

1. POWAI THE ANGLING PARADISE. By D. I. Amore. 80 pages: Hind Kitabs Limited, Bombay-1. Price Rs. 4.

A new book on angling is always welcomed by followers of Izaak Walton in India. In fact this little publication on Bottom Fishing goes a long way to fill the gap since Mr. Thomas's classic was first published some 70 years ago. The author is one of our Powai Lake veterans and has also incorporated the views of a number of other old timers. To my knowledge this is the first publication on Bottom Fishing with particular reference to Bombay waters and it will be found indispensable for beginners and visitors from abroad and from other parts of the country.

From the anglers' point of view, the fact that the author deals with a specialised subject, viz. Bottom Fishing at Powai Lake, appears to be a definite advantage as this Lake, which covers an area of 2.6 square miles, provides versatile and varying methods of angling for Bottom feeders such as Rohu, Mirgil, Calabos and Catla, of which the Lake holds very remarkable specimens, particularly Catla, of well over 100 lb. in weight.

A study of the Book will reveal that this Lake, contrary to what we usually call a 'Tank', can be successfully fished by various methods according to season and water level. The author also gives useful information on building rafts and boats suitable for fishing.

The tackle, as described by the author, time-proved by many anglers at Powai, will no doubt be found most suitable for any type of bottom fishing in other parts of the country.

One would have wished that the book contained a number of good photographs depicting the beautiful scenery at Powai and it is hoped that in a future edition this shortcoming will be remedied without an increase in price.

F.R.G.

2. THE TIGERS OF TRENGGANU. By Lt.-Col. A. Locke. Pp. xvi+191 (8.4/5″ × 5½″), 38 plates and 2 maps. Museum Press Limited, London, 1954. Price 16 *sh.* net.

The author was posted as an administrative officer at Trengganu; it was a part of his duty to destroy eleven tigers and eight tigresses. The present book is the outcome of his experience of about three years while he was in charge of the division, and of his studies of the habits of Malayan tigers.

Chapter one is mostly concerned with the background.

Chapter two deals with the distribution, size and habits of the tigers in Malaya and particularly in Trengganu. According to the author every ten square miles in Trengganu held one tiger, which he thinks is less than the estimated density in tiger country in India.

Malayan tigers appear to be smaller than Indian ones. From the measurements of the eleven tigers and eight tigresses shot by him, and from those shot by H.H. The Sultan of Johore, the average length of a Malayan tiger is given as 8 ft. 6 in., and of a tigress 7 ft. 10 in., against 9 ft. 6 in. and 8 ft. 6 in. respectively for the Indian animal.

The Malayan tiger is said to eject a strong smelling secretion from the root of the tail. A similar habit has not been recorded in India. The principal natural food of tiger in Malaya is wild pig. As other game animals are rather scarce, Malayan tigers become cattle lifters more frequently. Malayan tigers are very fond of dogs, while in India leopards are reputed to be so.

The proportion of sexes is given as 60% males to 40% females and the breeding season from November to March. The maximum number in a litter is given as six, which seems to be higher than in India. Milk teeth are kept for about six months. The second set of teeth are hollow, the cavities finally close after about twenty months. The new and permanent canines grow up inside the hollow milk teeth. The cubs are suckled for about five months after birth, after which the mother gives them small game to start with.

The maximum longevity is 25 to 30 years. The author collected all this information in about three years.

Chapter three deals with diet, kills and area covered. As already stated in Chapter two the principal diet is wild pigs with an occasional barking deer, sambar, peafowl, and giant sea turtles, which are turned on their back and eaten at leisure. The Malayan tiger is not averse to domestic cattle, sheep, goat, domestic pigs, dogs, tame monkey and poultry. The bigger animals are killed by biting; the breaking of the neck vertebrae being considered accidental. However, the author has not witnessed actual killing and his description does not agree with that of Dunbar Brander. Perhaps owing to its smaller size the Malayan tiger has to resort to a different method. The bigger animals are dragged and not carried. Like the Indian tiger, the Malayan tiger also starts eating the hind part of the kill. Frequently the Malayan tiger is a carrion eater. Malayan tigers do not, while walking, place their hind feet on top of pugs made by the front feet, as Indian tigers are supposed to do. The Malays use baited spring traps and noose traps to kill or capture tigers.

Chapter four deals with tiger hunting. Beating and stalks are not practicable in Malaya. Sitting up over a kill or accidental encounters seem to be the ways of killing tigers.

Chapter five and six deal with the different cattle lifting tigers the author has shot.

Chapters seven and eight deal with man-eating tigers. All the man-eaters shot by the author were males. From the accounts it would appear that the man-eaters of Malaya are much less cunning and formidable than those of India. In Malaya a man-eating tiger does not become so great a menace as the man-eater in India for the following reasons: (a) smaller area of operation, so easier to locate, (b) greater determination and skill of the Malays!!! (c) experienced hunters more readily forthcoming!!

Chapter nine is a collection of Malay superstition and legends.

During the short time at his disposal the author tried to learn as much about the Malayan tiger as possible, and has turned out a very interesting book indeed, though many of his opinions and conclusions do not agree with those of people who have studied and hunted tigers in India and elsewhere. The author was in the habit of following up a tiger immediately after wounding it, even at night. What experienced shikaris in India will think of this practice can well be imagined. The author's attempt to make a census of tigers in Malay may usefully be tried in India. His sincere admiration for a noble animal is apparent all through the book.

B. BASU.

3. PELICAN IN THE WILDERNESS. A NATURALIST'S ODYSSEY IN NORTH AMERICA. By F. Fraser Darling. Pp. 380 ($8\frac{3}{4}'' \times 5\frac{1}{2}''$). With 2 maps and 15 plates (28 photographs). London 1956, George Allen and Unwin. 25 *sh.* net.

Dr. Fraser Darling is well known as an authority on wild life and his writings have done much to bring about an increasing recognition in Britain of the importance of Nature Conservation. His most recent book describes his travels in America. Somewhere beyond Wall Street and the Pentagon, Broadway and Manhattan, the high-powered cars, escalators and chromium plating lies the America of the pioneers, the America of wide prairie, virgin forest, desert and swamp. What have they done with it since the first homesteaders established their farms so many years ago? Dr. Darling supplies part of the answer. America is constructed on a vastly larger scale than anywhere else. Here under a magnifying glass are the universal natural principles at work, providing him with abundant confirmation for views based on observations in tiny insular Britain; and drastic illustration of the consequences of disregarding ecological laws.

The inter-relation between species in any habitat is so close that interference with one upsets the ecological balance. Man in the course of his phenomenal rise to become the dominant species of the present age has done this over and over again, often with serious and totally unforseen consequences. To give only one example, the author describes how the extermination of the timber-wolf in North America, instead of increasing the number of white-tailed deer, has led to their decrease. No longer kept on the move by wolf packs, the deer stay in one spot and after finishing all available food starve to death. In Scotland a role similar to that of the wolf is played by the sheep-dog, which drives the sheep from place to place and prevents over-grazing. If we are to control our environment intelligently an understanding of the factors holding natural communities together is essential, and this can only be acquired by a lifetime of patient observation.

Most interesting perhaps are Dr. Darling's remarks on soil usage, especially relevant in the context of India's plans for expanding her agriculture under the Five Year Plan. Are we relying too far on the fertility of our soil to repair damage done by forcing marginal soil to yield arable crops? Such a practice impoverishes the soil, and in satisfying present needs we may well be robbing future generations. Other parallels between Indian and American conditions can be drawn. 'There is immediate wealth to be picked up from breaking an ecological climax, as in the felling of Wisconsin's forests.' Writes Dr. Darling: 'The biological shock of doing such a thing is very great . . . .' The hacking of trees round our villages and the large-scale felling of timber by private owners in order to make quick profits are destroying what ought to be valuable natural assets. We are left with land which is practically worthless from the agricultural point of view and which may take centuries to return to the forest that represents the climax vegetation.

In some ways it is a pity that Dr. Darling has adopted the diarist's style, noting down events and thoughts as they occurred to him. Thus we find the price of a haircut in San Francisco next to a discussion on land misuse in California, and, immediately after, we are back in San Francisco's Italian quarter for dinner. Along with some interesting general information and some which is neither interesting nor particularly original there is much of value in the book. We may or may not agree with all Dr. Darling's conclusions, but he has a definite contribution to make to our thinking on matters of ecology, and it is to be hoped that this book will stimulate interest in his more serious scientific publications.

R.R.

4. THE FLAMINGOS: Their Life History and Survival. By Robert Porter Allen. Pp. xv + 285 (10½" × 8"). 15 plates (6 coloured), and numerous line figures from field sketches etc. New York: National Audubon Society, 1956. Price $3.95.

This is the National Audubon Society's Research Report No. 5. Though it covers all the flamingos of the world, it has special reference to the American or West Indian Flamingo, *Phoenicopterus ruber,* which is threatened with extinction in portions of its range. It is the result of some 3 years' field study of the species and analysis of the data collected.

To those familiar with Dr. Allen's previous research reports in the same series, namely on the Roseate Spoonbill and the Whooping Crane, and to any one who, like the reviewer, has had the privilege of seeing this dedicated field ornithologist in action, this magnificent piece of work is only what was to be expected. Indeed the National Audubon Society are to be congratulated on their choice, for here Dr. Allen has done it again!

Properly organized interest in the American Flamingo began to be taken only recently since the realization of its fast declining status by a group of far-sighted naturalists headed by Mr. Arthur Vernay, and more particularly after the founding of The Society for the Protection of the Flamingo in the Bahamas—'the largest remaining stronghold of the American flamingo'. Owing largely to ceaseless persecution by local inhabitants the bird was being rapidly pushed to the verge of extinction.

The Report is divided into the following main sections: (1) Distribution & Migration, (2) Numbers, (3) Food Habits and Ecology, (4) The Breeding Cycle, and (5) Conservation. An Introduction at the beginning provides a very full overall background survey of the flamingo through the ages and throughout the world: legend and early history, classification, comparison of species including detailed descriptions of all the six forms belonging to the three genera currently recognized. The large flamingo of the Old and New Worlds, treated by some taxonomists as races, is given specific rank as *Phoenicopterus antiquorum* and *P. ruber* respectively, with a third species of this genus, *chilensis,* confined to Chile in S. America.

On the map on p. 33 of the Distribution and Nesting of *P. antiquorum* in relation to isothermal lines, reported former nesting is shown in Ceylon. It may be well to point out, however, that a scrutiny of these reports have proved them to be groundless and based largely upon conjecture and speculation.

The author believes that the enormous breeding colonies of the Great Rann of Kutch—the most populous so far known anywhere in the world—send their flocks to E. Africa for the winter months, at least large numbers of them. This is a reasonable speculation, but can only be proved by a large-scale marking of the birds. In fact most of the existing distributional problems connected with the flamingo seem capable of solution only through large-scale marking and adequate follow-up.

An estimate of the present aggregate of the West Indies Flamingo (*P. ruber*) at five of its principal known nesting places is given as 21,500 breeding adults. It shows a slightly downward trend since 1952 when the total of the adult breeding birds was estimated at 23,416. A hope is expressed that the continuation of the present protection programme instituted by the Flamingo Protection Society of the Bahmas, and other agencies, will, with the help of the vital statistics presented in this Report, help to rehabilitate population numbers. It is concluded from an analysis of the data available that formerly the total population numbered something like 95,000 individuals, distributed in 12 major and 17 minor population units.

Apart from human persecution, the West Indies flamingo suffers drastic loss through the periodic hurricane cycles to which its distributional range here is exposed. On account of these recurrent catastrophies it is believed that the numbers of this species were never as great as those of its Old World congener.

Perhaps the most illuminating chapter is that dealing with Food Habits and Ecology. All available information has been skilfully collated and supplemented by the author's own extensive field study. It is pointed out that the factor of high salinity, common to all flamingo habitats, is perhaps of the most consistent vital survival value. High salinity tends to produce the abundance and variety of the minute organisms upon which the flamingo feeds. The large size of the bird's tongue which fairly fills the mouth cavity precludes the swallowing of large food items. The food is confined to vegetable and animal items mostly of tiny or even microscopic size, largely swallowed in the form of organic sand or mud. But a study of the bird's feeding places suggests a great many potential food items besides those taken from stomachs, so that there is still room for exhaustive studies on the food and feeding habits of the flamingo.

The chapter on The Breeding Cycle describes in detail breeding behaviour, pair formation, courtship, copulation, nest building and other matters connected with incubation; also hatching and early behaviour, herding, and dispersal of the young. The final section of the Report deals with Conservation. The main causes of mortality are put down as human encroachment on erstwhile remote habitats, and natural physical causes such as storms, cold waves etc. One such alone in the Camargue last year is known to have killed off over 2,000 birds. Natural predators do appreciable damage in some areas, but this does not appear to be a major limiting factor. Nearer home, in the case of our Kutch colonies, the growth of the practice, apparently within recent years, among villagers around the borders of the Great Rann of organized rounding up and slaughtering large numbers of flightless young flamingos has become a serious menace. At this stage the young are unbelievably fat and are greatly relished as food by the meat-eating locals. The newly appointed flamingo warden of the Government of Kutch will, it is hoped, be instrumental in curbing this vandalism.

Conditions in all the known flamingo breeding areas are reviewed and the measures for protection already adopted or called for are described or suggested. Dr. Allen concludes that perhaps except in the case of the Andean species *Phoenicoparrus jamesi* about which not enough is known, the overall world position of the flamingos, barring in certain specific areas, e.g., in the Carribean region, is fairly satisfactory and happily presents no serious problems of survival at present.

The Bibliography is impressive. It occupies 21 pages and cites something like 700 separate items covering practically all that has ever been written about the flamingo. The Report is, in fact, a comprehensive epitome of our knowledge concerning the bird.

A frontispiece in colour by R. T. Peterson illustrates all the six flamingos of the world showing their comparative characteristics of size and coloration. The other five coloured plates unfortunately do not all do justice in their reproduction to their original transparencies, but the monochrome plates are good and the line drawings excellent and well-chosen throughout, including the various maps.

S.A.

5. EMBRYOLOGY OF *HETEROMETRUS SCABER*. By A. P. Mathew. Zoological Memoirs, University of Travancore Research Institute. Vol. I, pp. 111. Frontispiece and 14 plates. Trivandrum, September 1956.

The *Memoir* by Dr. A. P. Mathew on the embryology of the Indian scorpion, *Heterometrus scaber*, forms a valuable contribution to the embryological literature on the development of Arthropods. After a historical resumé, the author describes briefly the material worked with and the technical methods followed in the study. He then gives a brief account of the bionomics, the female reproductory system, the structure of the egg, the details of maturation and fertilization, the segmentation of the egg, the development of the blastula and the processes of gastriation. This is followed by accounts of the development of the mid-gut, the nervous system and certain other organs of the body. Toward the end is given a brief account of the birth of the young ones. This scorpion breeds throughout the year in southern India and is viviparous.

It is clear that the author has carried out a useful and painstaking study of scorpion embryology. He has taken care not only to give his findings in detail but also to discuss them against the background of previous knowledge. In this way the reader is able to judge for himself the value of the findings and the extent to which they are original.

The account is well-illustrated with several text-figures, 14 plates and a frontispiece. We should like to congratulate the author on bringing out this fine *Memoir*. Also deserving of congratulations are the University of Travancore which sponsored the publication and the University Grants Commission of the Government of India which provided financial aid to the publication. We shall look forward to the publication of subsequent Zoological Memoirs which, we hope, will maintain the high standards set in the first *Memoir*.

M. L. ROONWAL

6. THE EARLY EMBRYOLOGY OF *PYRILLA PERPUSILLA* WALKER (HOMOPTERA) INCLUDING SOME OBSERVATIONS ON THE LATER DEVELOPMENT. By Klaus Sander. Aligarh Muslim University Publications (Zoological Series on Indian Insect Types. Edited by Dr. M. B. Mirza). 1956. Price Rs. 5.

Embryological work on insect types has not found favour with Indian entomologists. In fact except Dr. Roonwal's paper there hardly exist any standard papers on the studies of insect embryology in India. Dr. Klaus Sander's present paper is a good beginning in this direction. The author in this paper has brought in a keen sense of observation as he follows the different stages of early development. Regarding the description one feels that it could have been shortened. Immediately after Material and Methods the author could have taken observations, and instead of bringing controversial matter under this heading it would have been better to put it under discussion. Under this heading the different papers on early development could have been discussed and the present observations compared. By doing so a running observation would have made better reading than getting mixed up with comparisons and controversies. Similarly the use of such words as Ental membrane, Mycetom, Vorkeim-Anlage, Symbionts and a number of others are probably not commonly used in the English vocabulary of this nature. A note explaining them would have helped many readers. We feel that in further work of this nature the precision and clarity as seen in the papers of Dr. Heymons, Paterson and Miller would be very helpful to Indian workers.

However, Dr. Klaus Sander has certainly opened up in India a new line of work and we hope that many Indian workers will profit by the same.

P.J.D.

MISCELLANEOUS NOTES

1. MACAQUE MONKEY EATING MUSHROOMS

The macaque monkey, *Macaca mulatta* (Zimmerman), is common in the New Forest estate of the Forest Research Institute near Dehra Dun (Uttar Pradesh), *ca.* 600 metres above sea-level. It moves about the estate in small troops, doing depredation to gardens and cultivation. During the summer monsoon, mushrooms spring up profusely from the ground all over the area. They usually acquire a whitish umbrella-shaped body which attains a height of upto 4 cm.

One day in August, 1955, I saw a large male macaque pulling out and eating these mushrooms with relish. A few days later another male was observed repeating the same performance. The observation seems to be worth recording. As several species of mushrooms grow in Dehra Dun, I am unable to say which species the monkeys were eating.

Zoological Survey of India,
Calcutta, M. L. ROONWAL
September 24, 1956.

2. LION *V.* TIGER

Col. Kesri Singh's interesting Miscellaneous Note entitled 'Experiments in Implanting African Lions into Madhya Bharat', in Vol. 53, pp. 465-68 of this journal, gives the details of how lions were imported from Africa into Gwalior in 1916. This information is most welcome, especially as we are now concerned with the proposal of moving a few lions from the Gir Forest into some other parts of India. (See my paper entitled 'The Management of India's Wild Life Sanctuaries and National Parks' in this issue of the *Journal,* pp. 1-21.)

An interesting point was raised, also, in the details concerning lions versus tigers in combat. Col. Kesri Singh is of the opinion that the lion was ousted from its habitat in India by the tiger, but this is not confirmed by some naturalists. R. I. Pocock, for example, in his Fauna of British India, Mammalia, Vol. I, pp. 220-221 gives emphasis to the slaughter of lions in India by sportsmen and others; particularly by British army officers during the nineteenth century. This shooting out of lions, he maintains, was the real cause of their disappearance in India, while the more wary tiger managed to survive.

In support of this theory, Pocock points out that lions have also disappeared from parts of Europe, SW. Asia and Africa, where there were no tigers to interfere with them. I am indebted to the Jam Sahib of Nawanagar for the information that in many parts of NW. India, where the lion has disappeared, there were never any tigers to contribute to this.

Pocock goes even further by suggesting that the lion entered India from the NW. and was able to spread as far south as the Narbada River in spite of the previous occupation of many of these parts by the tiger, which (according to him) had probably entered India previously from the NE. to spread down to the tip of the peninsula.

Pocock also is of the opinion that even if a lion and tiger did exist in the same region, their difference of habit and habitat would not necessarily bring them into actual conflict with each other, and that 'an encounter would just as likely end in mutual avoidance as in a fight, and in the event of a fight the lion's chance of success, so far as anything is known to the contrary, would be as good as the tiger's. Hence there does not appear to be a particle of evidence that the tiger played even a subordinate part in the extermination of the lion in Inda.'

Now for the fate of some of the African lions when released into Gwalior forests. Col. Kesri Singh has explained how these three pairs of lions were confined in a 20 ft. stone wall enclosure 'for about 4 years' before being released. Col. Kesri Singh has very kindly informed me in a letter that the size of this enclosure was only 'about 100 ft. square'. This must surely have been a very severe handicap to the lions—to be thus confined for four years and then released straight into tiger country. Imagine a few tigers confined for four years in a similar enclosure in the Gir Forest and then released to fight the Gir lions on their 'home ground'!

Col. Kesri Singh refers to three duels arranged by him between tigers and lions, in which the tigers won on each occasion. In this connection it is interesting to note that the Jam Sahib of Nawanagar has informed me that he has himself witnessed a fight between a lion and a tiger on four occasions, on all of which the lion won.

My own humble opinion is that I do not think much importance should be attached to whether the lion or the tiger was victorious in any particular duel *unless the two animals were equally matched in every respect*. In other words both tiger and lion would have to be the same sex, same age, same weight (relatively), same condition, same duration of captivity, same length of time since last feeding and drinking, etc., etc. The combat would also have to be arranged under such conditions and circumstances that neither animal had any unfair advantage over the other. To organise such a combat would be extremely difficult—in fact almost impossible.

There is also another aspect to be considered. It has been the practice of many makers of nature films, especially of the Hollywood and more recent T.V. Schools, to present only the sensational. Their animal films include staged fights between captive animals unnaturally forced to fight each other, and ferocious charges by deliberately provoked animals, simply to pamper audiences which are ignorant of real jungle conditions and which have become accustomed to a series of excitements and thrills in nature films. This is most unfortunate, since not only are such films an unreal portrayal of wild life, but also when a serious field naturalist produces a genuine wild life film of what he has actually seen, it is likely to appear flat and uninteresting after those made by the 'animal fight' school.

Having seen African lions in East Africa and Indian lions in the Gir Forest, I have immense respect for these creatures. And having seen tigers in various parts of India, I have the highest admiration for these. Both animals in their own different ways and in their own different habitats are equally worthy of our admiration. I would rather think of them as mutually respecting and avoiding each other if they happened to meet in the wild state.

Doyang T.E.,
Oating P.O., E. P. GEE
Assam,
August 20, 1956.

3. TRANSFERRING OF THE INDIAN LION TO AN ADDITIONAL LOCALITY

There has been much thought given recently to the moving of lions from the Gir Forest to other parts of their former range. The idea no doubt is to insure the future of this noble animal from possible extinction by man or through epidemic diseases or other natural catastrophies, and as such is to be welcomed. Is there however, any need to do this at all?

In the Gir Forest the lions live out in the surrounding cultivation and less in the forest itself, except in the eastern part of the reserve. Lions are animals of the open country and do not like forests. That they are found in the Gir is no doubt owing to the broken nature of the terrain which allowed the last of the animals shelter from the shikaris who wiped them out over the rest of the country, and possibly also, due to the great numbers of cattle grazed in the forest, providing them with a plentitude of food. In former times the lions ranging across the north-west of India must have fed on nilgai and buck which were found in plenty in the areas frequented by the lions. Now where is there a place where these antelopes can be found in the concentrated numbers sufficient to support a pride of lions? As in the case of tiger, cattle are a substitute in place of the lion's natural food, while other forest game such as cheetal can never form the sole diet of the lion. Bearing this in mind, would it be fair to impose economic loss on people living around the proposed new lion sanctuary, and has the danger to these people who are not familiar with the lion and his ways been considered? Finally, what will prevent the lions from wandering away as they apparently did when some were introduced by the Maharaja of Gwalior in his forests several decades ago? These are questions which cannot be lightly dismissed.

Another problem which needs to be looked into before trapping of the lions commences is that of housing them while the full family is being caught, and till they are moved to their new home. It is obvious that the present accommodation in the Junagadh Zoo is limited and not desirable, since I have found there a tendency among the keepers and some visitors to annoy the animals. This infuriates the lions, which is only natural, as well as removes the respect they have for man in their natural state. What the consequences will be when these animals are released in their new home is too fearful to imagine —witness the killings by the lions which recently escaped from the Junagadh Zoo.

Granted that all the above objections are removed, on what grounds has the need for this sort of transplanting become necessary? Lions have existed in the Gir for centuries and even if in the past epidemics might have reduced the race, they have always managed to multiply again to their former numbers, so it has never been claimed that the present reduction of the once widely spread lion to its limited habitat has resulted from causes other than their destruction by man and by depopulating of the game that comprised their food. Since the killing of lions has been completely banned, the Gir lions have kept on increasing most vigorously, and there is every possibility that if the animals are given continued protection, they will slowly spread out into the country around their present range. This natural increase will create a need to keep their numbers down by judicious shooting. It is therefore apparent that there need be no anxiety about possible extinction of the lion in the Gir and consequently this scheme is quite uncalled for, unless of course it is intended to give another State the pride of being the possessor of Asiatic Lions. This privilege, however, is fraught with much danger and is not worth the effort.

RAJKUMAR COLLEGE,
RAJKOT, SAURASHTRA, K. S. LAVKUMAR
September 29, 1956.

[Mr. E. P. Gee, who is particularly interested in this problem, comments on the above as follows:

'While it is true that the Gir Forest and its surroundings may be an ideal habitat for Indian lions, this is not the sole reason for their survival there. Another reason is that they were protected by the former Nawab of Junagadh, whereas they never received any protection in any other part of India.

As to imposing an "economic loss on people living around the proposed new lion sanctuary", the importance of doing publicity about the lion and its habits in the event of a new home for the Indian lion being proposed, was accepted and emphasised at the last meeting of the Executive Committee of the Indian Board for Wild Life. Only if the State authorities and the people of the neighbourhood are in favour of having lions brought into their area should such a project be undertaken.

The case of (African) lions being introduced into Gwalior State some years ago cannot fairly be cited, as the conditions under which these lions were released into the forest were far from ideal.

In addition to chital, it is presumable that sambar, pig and other such animals will also constitute the food of lions re-introduced into a new locality within their former range. It was never intended to re-introduce the lion into an area unless there was an adequate *natural* food supply to enable it to survive without *necessarily* having to prey on domestic cattle.

If lions are ill-treated by keepers in the Junagadh Zoo, this should be speedily reported to the appropriate State authorities, possibly with a copy to the Secretary, Indian Board for Wild Life.

It is a fact that the Indian lion is *at present* not only safe but actually on the increase in the Gir; but in addition to the danger of diseases, droughts, famines and other *natural* calamities, there is also the risk of *un-natural* calamities such as wars, civil commotion, total deforestation, uncontrollable killing etc. which have to be guarded against. Moreover, there appears to be a genuine desire on the part of certain other States in India to re-introduce a valuable, important and interesting animal into their forests.'—EDS.]

4. WILD ELEPHANTS IN THE UNION OF BURMA

CENSUS

A careful census made in 1935 put Burma's elephant population at about 10,000 head. Reckoning on 6,000 of these being females, and half of these being of breeding age, and at the rate of one calf in four years, the average annual birth-rate would be 750. From this substract 125 natural deaths each year, which leaves the average of annual increase of 10,000 animals at 625.

WILD ELEPHANT CONTROL SCHEME

A comprehensive scheme of wild elephant control in which game rangers worked in conjunction with kheddah operators was sanctioned in 1935. A number of permanent blocks were selected and the objective of the scheme was the extermination of elephants living outside these blocks. Very considerable damage to crops was done by wild elephants, which would in future be confined to areas as remote from cultivation as possible. It was estimated that a stock of between 4,000 to 5,000 wild elephants would be retained in the permanent blocks. The game rangers were employed chiefly on crop protection up to 15th January, after which most of them were engaged in extermination operations.

PLAN OF KHEDDAH OPERATIONS

All licences for capture of elephants were issued under the elephant control scheme. Under this plan certain areas were closed to operations as elephant sanctuaries, others were classified as areas in which the extermination of elephants was desirable in the interest of the country's development, and the greater part of the forests in which wild elephants occurred was divided into a number of kheddah blocks to be worked over in rotation by kheddah licensees.

Destruction of elephants resulting from the elephant control scheme and other agencies.

1935–36 to 1940–41

Burma		
Killed	2,810	
Captured in kheddahs	1,262	
Total ...	4,072	... 4,072
Federated Shan States		
Killed	419	
Captured in kheddahs	24	
Total ...	443	... 443
Grand Total ...		4,515

In justification of the large number of elephants deliberately killed, the Chief Conservator of Forests wrote:

'The elephant control measures adopted in 1936 have produced good results and should prove of lasting value. Further extensive operations should not be necessary. During the period 1935-36 to 1939-40, 2,131 elephants have been destroyed by game rangers, 277 elephants have been destroyed by other agencies, and 911 elephants have been captured in kheddahs. During the coming year, operations will be continued on a reduced scale. It is almost certain that a small staff of game rangers will have to be maintained permanently for crop protection work around permanent elephant blocks.'

The Annual Report on Forest Administration in Burma 1939-40.

'Elephant control scheme in the Mongmit Division (Federated Shan States) was abandoned shortly after the beginning of the year owing to the shortage of ammunition. The abandonment of the scheme has not seen any increase in destruction by wild elephants and it is probable that the villagers would be freed from serious trouble for a number of years to come after the destruction of 179 elephants during the three years in which the control scheme was under operation.'

Annual Report on Wild Life Preservation in the Federated Shan States for the year ending 31st March 1941.

In 'Wild Life Protection in Burma' published during World War II by the Public Relations Department, Government of Burma, Simla, H. C. Smith writes:

'Conducting Kheddah Operations: Some years ago it was estimated that there were about 5,000 wild elephants. As many as 500 have been captured in a year but in future about 200 will probably be the number that can be captured annually without detriment to the stock that it will be deemed advisable to maintain.'

Figures of elephants killed and captured in 1941-42 are not available. During the War period kheddah operations were suspended. The number of wild elephants shot illicitly must be negligible. Adopting the 1935 formula the increase during the war period 1942-43 to 1944-45 would be about 1,250.

The number of wild elephants in 1945-46 would be about 5,000 + 1,250 = 6,250.

In 1947-48 kheddah operations were conducted in Maritime, Sittang, Hlaing and Northern Circles. From 1949-50 to 1950-51, kheddah operations were confined to Maritime and Northern Circles. In 1951-52 kheddah operations were confined only to the Northern Circle.

The number of elephants shot from 1945-46 to 1951-52 is 29.

The increase from 1945-46 to 1951-52 would be about 2,750.

PRESENT POLICY OF GOVERNMENT

In order to build up the present inadequate elephant power for the timber extraction industry to its pre-war strength, the Government encourages kheddah operations whenever possible and issues kheddah licenses liberally to those who want to capture wild elephants. Such licenses are issued to cover an area of sufficient extent where elephant herds are seen to forage more or less regularly. The area is properly defined, and within such area a few kheddahs, up to 4 generally, are built in places most likely to be used by elephants in their runs during beats. The license fee is just a nominal sum, but on each captured elephant the Forest Department levies royalty at rates depending on the height of the elephant. The only condition upon which the Forest Department insists is that the area to which the license applies should be possible for Forest Officers to inspect. In other words licenses are given only for those areas where there is sufficient security.

At present such licenses are issued in Maritime Circle and Northern Circle, that is to say in the forests of Arakan, Tenasserim along the coast, and also in the Kachin State. The yearly average of elephants captured is 150.

The total number of elephants captured in Burma and the Kachin State from 1945-46 to 1951-52 is as follows:

Number captured	Number died, released or escaped	Balance
909	140	769

Number of elephants killed in Burma and the Kachin State from 1945-46 to 1951-52 is 29.

Kachin State.

Large herds including many tuskers cause considerable damage to taungya cultivation in the Suprabum and Putao sub-division. In 1952, a rogue elephant was shot to protect the timber elephants of the State Timber Board. The number of elephants captured during the last three years 1952-53 to 1954-55 is as follows:

Number captured	Number died, released or escaped	Balance
129	28	101

Total number of elephants killed from 1952-53 to 1954-55 is 9.

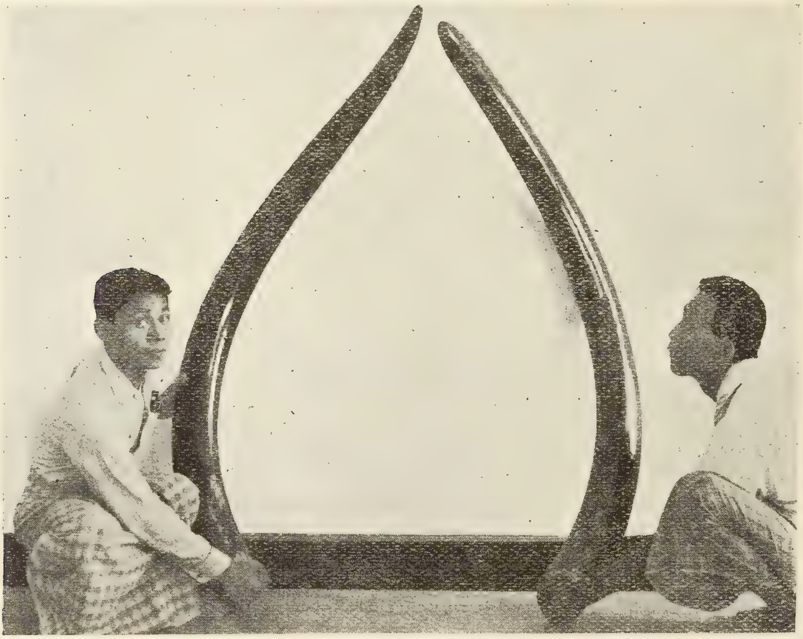
25 Inya Myaing Road,
University P.O.,
Rangoon,
August 23, 1956.

TUN YIN,
B.C.S. (Retd.)

5. A LARGE PAIR OF ELEPHANT'S TUSKS FROM BURMA

(*With a photo*)

In the Society's *Journal* 37: 468, J. K. Stanford has given a description of a large pair of elephant's tusks which he saw at Lonkhin, in the house of Kansi Duwa. He did not get the opportunity to weigh the tusks then.



This pair was brought down to Rangoon recently and were found to weigh 180 lb., when weighed at the air strip, Myitkyina.

The measurements and weight of these tusks therefore are:

Length	Girth	Weight	Remarks
R–6′–5½	17½″	180 lb.	Owner—Kansi Duwa.
L–6′–7½	17″		

For comparison, measurements and weights of some other large pairs of Burmese tusks are given below.

Extracts from Appendix I—Burma Game Manual 1929.

Length	Girth	Weight	Remarks
R–8′– 9″	...	...	Government House Rangoon (R. W.)
L–8′–6″	...	...	
R–7′–3″	17½″	102 lb.	The tusks of the sacred white elephant from Mandalay Palace. Owner—The Marquis of Waterloo. (R.W.)
L–7′–3¼″	17″	97½ lb.	
R7′–9½″	17½″	72 lb.	Shot by J. N. Clough. Kyaikto District 1896 (I.F.S.B.)
L–8′–6″	17″	74 lb.	
R–6′–8″	18¼″	84 lb.	Owner—H. Shaw Dum. (R.W.)
L–6′–5″	18¼″	82 lb.	
R–6′–11″	15½	106 lb.	Owner—Gordon Smith (R.W.)
L–6′–6″	15½		
R–6′7″	17″	110 lb.	Shot by H. E. Flint. Mogok Forest Division
L–5′–9″	17″		
R6′–2½″	17¼	...	Shot by A. Hazlehood. Basein Forest Division.
L–6′–1¼″	17½	...	

Extract from *The Burmese Forester.* Vol. V, No. 2.—December 1955. (Page 134)

Length	Girth	Weight	Remarks
R–7′–11½″	16½″	138·6 lb.	A big tusker shot at Hnokeho, Bhamo Division in 1936 by U Su.
L–7′–11″	16½″		

25, Inya Myaing Road,
University P.O.,
Rangoon,
August 23, 1956.

TUN YIN,
B.C.S. (Retd.)

6. ALBINO ELEPHANTS

Early in the present century an albino elephant calf was captured by the Government kheddah department in the Katha Forest Division. The calf was presented to the Trustees of the Shwe Dagon Pagoda, but died shortly after arrival at Rangoon as a result of over-feeding by pilgrims.

Later in the century, one was captured in the Toungoo Forest Division. The owner Saw Durmay Po Min, took the albino elephant along with one black elephant for exhibition in Europe and America. On the return journey, the elephant died at

Calcutta. A photo of this albino elephant is published in 'Wonders of Animal Life' Volume 3, page 1,026.

In 1939, a game ranger employed on elephant control in the Ngaputaw Township in the Henzada-Bassein Division, was charged in heavy bamboo jungle by an elephant, which he had to shoot in self defence. The animal on examination, turned out to be an albino. In 1940, a game ranger operating in the Mayu Hills of Arakan Division was also compelled to shoot an albino elephant.

25, INYA MYAING ROAD,
UNIVERSITY P.O.,
RANGOON,
August 23, 1956.

TUN YIN,
B.C.S. (Retd.)

[To the above records may be added that of the white calf born to one of the elephants of the Bombay Burmah Trading Corporation Ltd. In a note published in the *Journal* at the time (Vol. 26, p. 286—Decr. 1918), Sir Henry Macnaughten gave this interesting information: 'A female calf born on 6th March 1918 aroused a good deal of excitement by its unusually light colour, and in view of the importance attached by the Burmese to the birth of a genuine SINPYUDAW it was thought advisable to submit the claims of the calf to a jury of prominent Burmans on the 7th April.

'The points of a SINPYUDAW appear to be as follows:

1. Twenty toes,
2. Pearl eyes,
3. Tail 'Tah Gah Paik,'
4. Red mouth,
5. Light coloured and smooth skin.

'The calf though possessing a rather light skin at birth and pearl eyes failed to fulfil these conditions, having only eighteen toes and a tail that was not up to the requirements. It was therefore at once pronounced to be not a genuine SINPYUDAW.

'The colour has since grown perceptibly darker and on reaching maturity is not likely to differ in any way from the ordinary.

'The fact that the "whiteness" of an elephant depends as much on the possession of certain points as on its colour may be of interest to your readers, as most people appear to believe in the existence of a milk white animal.'

In a letter to *The Field* of 16 Decr. 1926, (reprinted in the *Journal* 32: 214), D. F. Macfie records the birth of a similar calf to one of the Borneo Company's timber elephants in N. Siam. Local experts pronounced it to be a true 'Chang Peuak' or White Elephant, a verdict which was confirmed by a specially deputed official of the Royal White Elephant Department in Bangkok. 'The chief "points" looked for in such elephants' writes Mr. Macfie, 'appear to be (1) a light red skin, the lighter the better, with still lighter coloured patches on belly and inside of legs; (2) white hairs on body and tail; (3) a very light pink palate or roof of mouth; (4) eyes a light bluish-pinky colour; (5) white toe nails. The number of toes does not seem to matter materially, but five on each foot, fore and hind, is considered, I believe, a mark of high caste.'

[In Vol. 46 (p. 396) is published a note by Mr. E. S. Simon (with photograph) of a cow elephant captured in the Travancore forests which, on the basis of the above 'points' was a true 'White Elephant'. This, apparently, is the first record of such an albino in the Indian peninsula.—EDS.]

7. PREDATOR AND PREY AT SALT-LICKS

In forest where there are salt-licks, earth-licks or hot-springs, one finds tracks of wild animals coming from all directions to a single focal point. The same applies, to a certain extent, to an isolated water-hole. Wild elephants, gaur, sambar, chital and barking deer (speaking of NE. India) visit these licks regularly.

It would be interesting to know if predators such as tiger and leopard ever take advantage of the existence of these licks, to lie in wait for their prey. And do the big cats themselves ever visit the licks for medicinal purposes?

It is possible that deer and other animals, when visiting an open salt-lick along well-worn paths, exercise greater care than usual. I have observed barking deer approaching a lick with the utmost alertness and caution, and I feel that this may deter the predators from attempting to ambush them.

E. H. Peacock (*JBNHS* 37: 780) writes: 'Some natural law appears to protect the game at these licks from ambuscade by the carnivora; at least I like to think so. I have never seen or heard of a kill at, or very near, a salt-lick'. Theodore Hubback (*JBNHS* 41: 48 *et seq.*) mentions having twice seen a tiger at salt-licks in Malaya, but does not refer to their drinking there, or killing their prey, or refraining from killing.

F. W. Champion in his book 'The Jungle in Sunlight and Shadow' (page 108) explodes the myth that there is any kind of truce between the jungle animals at times of drought, when water-holes are few and far between.

At the main hot-spring in the forest in Garampani Wild Life Sanctuary in Assam tracks of tiger have often been seen, and once a friend of mine actually saw a fine tiger there in broad daylight. Last October when accompanying the Senior Conservator of Forests to this place we found the remains of a half-grown gaur at this hot-spring. As there were no traces of a poacher's *machan* nearby, we presumed that it had been killed by a tiger or large leopard.

It would be interesting if any members of the Society or their friends can give more information on this interesting aspect of salt-licks.

DOYANG T.E.,
OATING P.O.,
ASSAM,
June 6, 1956.

E. P. GEE

8. INCUBATION PERIOD AND 'MORTALITY RATE' (?) IN A BROOD OF THE MAGPIE-ROBIN [*COPSYCHUS SAULARIS* (LINN.)]

Looking through my notes, I find the following entries in respect of the Magpie-robin which, as throwing some light on the period of incubation and 'rate of mortality' (?) of the chicks, may be worthy of record.

A nest was discovered on 28 February 1953 in a hole *ca.* 9″ deep at the tip of a 5-foot bamboo stake in the fence forming the boundary of the Zoological Gardens at Trivandrum. The fence was in bad repair and the stake, loose from its anchorage was leaning forward at such an angle that the nest was hardly more than 3 ft. from the ground.

28-2-1953.	Four eggs, greenish and liberally blotched.
14-3-1953.	One egg hatched in the afternoon.
15-3-1953.	The remaining three hatched.
24-3-1953.	Nestlings show a white patch on their bodies; very warm and humid.
29-3-1953.	Nestlings looking well.
30-3-1953.	At 10.30 a.m., three of the nestlings had disappeared and the 4th was crouched at the bottom of the nest; sometime later, it was found in an erect posture and quite dead. No trace of injury on the nestling; no sign of the others in the neighbourhood; the male parent was found later, calling from a nearby tree. The dead nestling was weighed (9.6 gms.) and transferred to spirit.

It can be seen from the above, that 15 days had elapsed between the discovery of the eggs and their hatching. Assuming that the nest was found the day the clutch was completed, perhaps a coincidence, or within a day or 2 of it which is more probable, the incubation period may be taken to be 15 to 18 days.

The fate of the nestlings remains a mystery. If they had been destroyed by predators, it is hard to see how the fourth could have escaped without so much as a trace of injury. Death from excessive heat or disease or starvation can also be ruled out as in such cases the victims should have been found dead or dying, within the nest itself. And besides, they were looking so well only the previous day!

There is a probability that the young birds had flown from the nest. This seems plausible in the light of the observations made by Dr. M. Nice in the course of her study of the Song Sparrow in America, that in Passerine species the majority attain flight proficiency at about 17 days of their hatching. In the present case, the chicks, already 15 days in the nest, may have gained sufficient strength to fly from the nest. This they might have done and in the 'stampede' that followed, their weakling brother (or sister) might have got choked to the point of death.

An examination of the preserved specimen showed that it had its wing feathers well developed, but the tail was nothing more than a flat knob with no feathers at all. The head and body were bare, save for a small patch of short, black feathers just behind the bill and a few feathers in a line at the beginning of the spinal ridge. The earliest rudiments of feathers could, however, be made out as a triangular patch on the chin, a thin line along each lower jaw and as a large inverted 'V' commencing from the gullet.

The white patch on the body referred to earlier, which had the appearance of a fungal growth, has disappeared in spirit.

'GOKULAM',
NANTENCODE, N. G. PILLAI
TRIVANDRUM.

[It appears more than probable that the three chicks left the nest in the natural course and that the fourth, being a weakling, was thereafter abandoned to its fate by the parents. This is not uncommon in passerine birds.—EDS.]

9. SOME NOTES ON THE PLUMAGES OF *CENTROPUS SINENSIS* (STEPHENS)

Stuart Baker (Fauna Vol. 4, p. 190) describes the young of *C. s. sinensis* (Stephens)—'Distribution: Northern India, roughly from Sind and Kashmir through the North-West Provinces, Punjab and United Provinces; the sub-Himalayas as far east as Eastern Assam and south to the Ganges Valley in Bihar and Bengal'—as having the plumage barred in young birds with a great deal of variation. He also records his personal observations regarding females, but not males, breeding in such juvenile plumage. He does not refer to the young of the other two races, i.e., *C. s. intermedius* (Hume)—'Assam, south of the Brahmaputra; Cachar and Sylhet, Tippera, Chittagong, Comilla, Burma, North Malay State, Siam and the Indo-Chinese countries, Yunnan and Hainan'—and *C. s. parroti* Stres.—'Ceylon and India, south of the range of *sinensis*'—implying that they are also barred as in the nominate race.

Whistler and Kinnear in their report on the Eastern Ghats Ornithological Survey, *JBNHS,* 37: 528, drew attention to the question of juvenile plumages in the Crow Pheasant (*Centropus sinensis*). They found some young similar to the adults, while others wore a barred plumage. They thought that this might be of subspecific significance, but stated that they did not have sufficient material to settle the point.

The Society's collection contains 7 juvenile skins which are barred on the parts mentioned against them:

♂ (Assam). Secondaries and upper tail coverts.
o ? (Bihar). Wings and underparts; tail missing.
o ? (Bihar). Wings, underparts and entire tail.
♀ (Bihar). Secondaries and central tail feathers.
* ♀ (Nepal). Most secondaries, central tail feathers and tail coverts.
♂ (North Shan State). All wing quills and coverts; traces on all tail feathers and underparts.
* ♀ (Prome Dist., Burma). Most secondaries; upper wing coverts and central tail feathers.

---

* Bear traces of duskiness, see infra.

A specimen from Gwalior has slight traces of bars on the tips of a few of the brighter purplish feathers of the hind neck, but otherwise it agrees with *parroti*.

Mrs. Cicely Lushington in a letter to the Society in December 1945 wrote: 'The fledglings of this bird in Ceylon, contrary to what is said in text books (Waite: Birds of Ceylon, p. 218), are just like the parents, but a little duller. Mr. W. W. A. Phillips has handled a number of fledglings and says that "he has never found any barrings in the Ceylon form".'

The only unbarred juvenile available in Bombay is one from Khandala, Western Ghats, Bombay State, collected on 4 October 1935. This is a ♂ and shows very slight traces of duskiness in the upper wing coverts. The wing feathers are not yet fully grown.

As the above suggested that the young of *parroti* may differ from those of the other two races in not being barred, I wrote to the British Museum and Mrs. B. P. Hall of the Bird Room very kindly examined the material available there. She writes that in an extensive series of *parroti* from Southern India and Ceylon there are no juvenile or immature specimens with barred wings or tails while there are juveniles, or immature birds, with barred wings and tails from Karnal; Jhang, Bhimbar District, Multan, Jagadhri (Ambala Dist.) and Lucknow; also from Bengal and all countries of eastern Asia.

Duskiness in Upper Plumage

In the course of this examination I was struck by the marked duskiness of the wing coverts in some individuals which contrasted sharply with the chestnut of the rest of the wings. Of 11 males and 20 females of all races, this duskiness was found in 8 specimens, all females of *parroti*, from the following localities: Bombay (2), Orissa and Bastar (4), Ambala (1) and Delhi (1)—all collected between 10 November and 15 January. Females of *parroti* taken in March (1), May (2) and September (2) showed no trace of this duskiness nor did any males taken in January (1), March (2), June (1), August (1) and October (2).

Except for slight traces on two juvenile females from Nepal and Prome, there was no duskiness in any of the other races though we have females taken in November (Meerut), December (Bhagowni, Bihar and Assam), January (Thayetmyo, Burma), February (Jagadhri, Ambala District, Punjab) and March (Bahawalpur, and Prome, Burma).

We have referred to the females from Delhi and Ambala as *parroti* while one collected by Basil Edwards in Delhi was named *sinensis* by Whistler (*JBNHS*, 31: 569).

Mrs. Hall has also referred to 8 adults from Delhi in the British Museum as *sinensis*. From Jagadhri, Ambala District, Punjab, we have in Bombay a female which is definitely *sinensis* while another dusky individual referred to above from the same district appears to be *parroti*. It would therefore appear that the distribution of the two races *sinensis* and *parroti* around Delhi and northward into the Punjab along the Jumna Valley has to be worked out afresh—there is either a mixed population with overlapping characters or both forms occur (?).

Summary

From the evidence available, it appears:

(1) that the juveniles of *C. s. sinensis* and *C. s. intermedius* are barred, while those of *C. s. parroti* are not.

(2) that the females of *parroti* acquire a marked sootiness on their wing coverts between about November and January.

(3) that there is either a mixed population or two forms overlap in the Punjab and northwards along the Jumna Valley.

MESSRS FAIZ & CO.,
75, ABDUL REHMAN STREET,
BOMBAY-3,
September 26, 1956.

HUMAYUN ABDULALI

10. THE OCCURRENCE OF THE PINKBREASTED PARAKEET (*PSITTACULA ALEXANDRI*) IN DEHRA DUN

On 14 November 1955, Mr. Gurdial Singh of the Doon School and myself, while sitting under a Toon tree in the school grounds, saw a party of these attractive parakeets fly into the tree, and we were able to watch them through field glasses on and off throughout the afternoon as they moved about in the branches overhead, feeding in clumps of loranthus parasitising on the toon branches. While feeding they were very quiet and their presence in the tree was only felt by the continual rain of leaves and other matter they dropped down while feeding or when attention was attracted by the whirr of wings as a bird flew from one branch to another. The flock consisted of over a dozen birds of both sexes, and when they flew from one tree to another they did so in a compact wheeling mass uttering loud and very distinct trumpeting calls quite unlike those of the Slatyheaded or the Alexandrine parakeet, both of which were around in fair numbers. The pink breast in the males is a very conspicuous feature as is also the rather short tail. Mr. George of the F.R.I. who is a knowledgable bird student of Dehra Dun informs me that this bird has never been mentioned before from the Dun.

RAJKUMAR COLLEGE,
RAJKOT,
SAURASHTRA.

K. S. LAVKUMAR

[The western limit of distribution given in the Fauna is 'Kumaon' without any specific locality.—EDS.]

11. EXPERIENCES WITH LITTLE RINGED-PLOVER

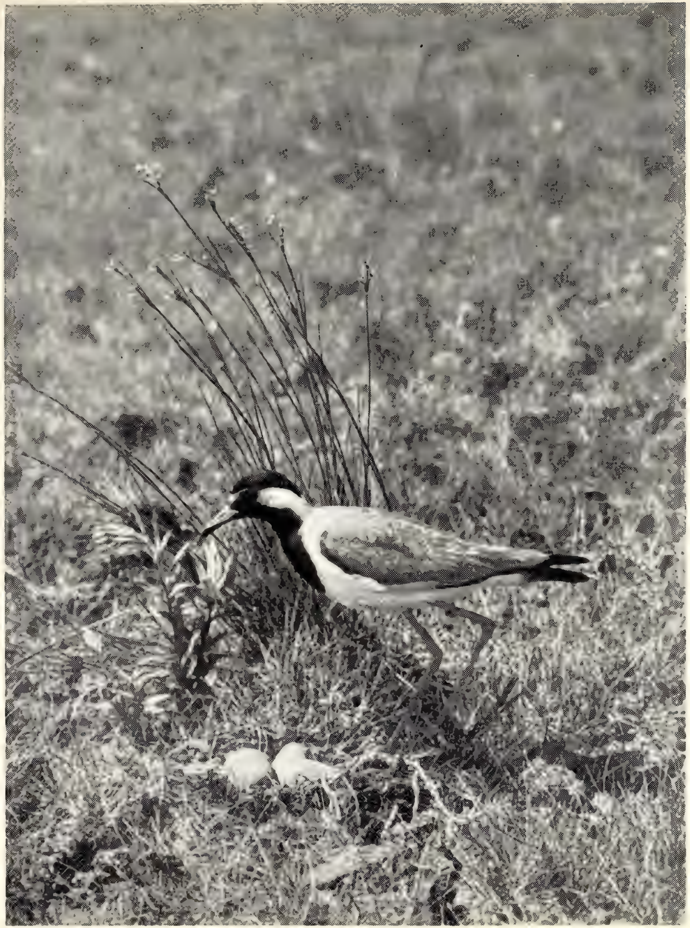
(*With a plate*)

The Little Ringed Plover (*Charadruis dubius*), is not a rare bird in Kashmir. Anyone looking for its nest may with perseverance and a little luck soon find it. It is not an excessively shy bird and seldom looks with great disfavour upon a photographer's hide, and yet my own attempts to photograph it in the summer of 1944 led to a series of adventures which culminated in the most surprising thing that has so far happened to me as an ornithologist.

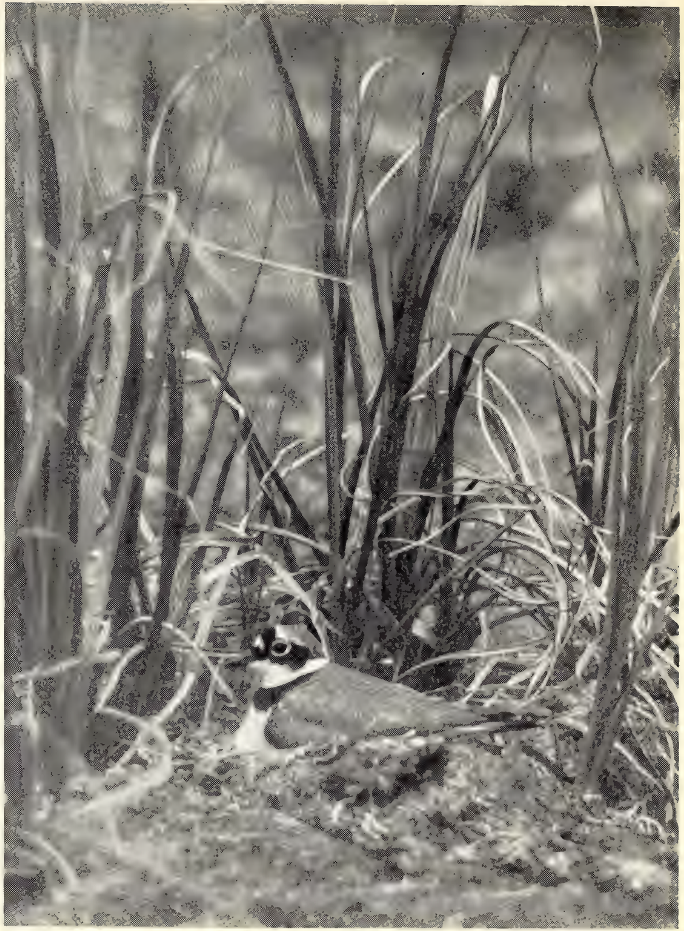
My first nest was found on an island of mud in the middle of a marsh. The marsh seemed bottomless and shivered with virgin horror at the touch of human feet. It was a perfect barrier protecting the island. Ditches intersected it in many places, and on the surface of the Lethe'd dullness of their waters the flowers of white water-lily floated like little waxen boats. To reach the island one either walks across the marsh in a series of hurried steps during which the weight of the body is never allowed to rest on one foot for longer than is absolutely necessary; or it is possible to use a rough kind of marsh-shoe consisting of a circle of withies attached by ropes to a central oblong of wood. Two lengths of grass rope tied to the central portion form a thong into which the foot is thrust, but the shoe is extremely uncomfortable to use.

On this first occasion, the island was soon reached. I crept into my hide which was already in place, trained my camera on to the nest and waited for the bird to return. The nest was a mere hollow scraped in the mud and contained three eggs; it was surrounded on three sides by tufts of straight-growing, sharp-pointed grass. Within a quarter-of-an-hour the bird was back and was photographed as it stood beside the nest. Unfortunately, the noisy shutter of my Graflex camera frightened the bird, and it flew off and made no further attempt to return. The plover, on subsequent occasions when frightened by the sound of the shutter would run a short distance from the nest, and then peck furiously at the ground, making the earth fly. Psychologists would explain this behaviour as a kind of 'karthasis', an outlet for pent-up emotions generated by the pull of two opposing emotional forces of equal strength: on the one hand a strong desire to incubate the eggs; and on the other an equally great desire to run away. (Similar behaviour under like circumstances I have also noticed in the case of another member of the family *Charadriidae*, the Common Sandpiper.) Fear, in the Ringed Plover, also finds emotional outlet in a raising of the leg which is shivered violently, an action resorted to by the bird when approaching the nest, literally 'in fear and trembling'.

The incubating bird, once frightened by the sound of the camera did not return a second time until driven back by its mate which until now had remained out of sight. The frightened bird had only flown a short distance away, and it was to be seen pecking at the ground for food, occasionally making a short run, and as it came to a stop performing a little hiccup of a bow. Now its mate came flying over calling, *Sweet-you, Sweet-you*, ordering the other in an urgent voice back to the eggs; together they returned to the nest and stood on opposite sides looking at it, and bowing to each other in their curious jerking fashion. After seeing its mate safely back in the nest, the second bird then flew away. For one reason or another the incubating bird left the nest on five occasions, but each time returned to it.



Redwattled Lapwing *(Hoplopterus indicus)*



Little Ring Plover *(Charadrius dubius)*

Photos: Loke Wan-Tho

Photographing the Little Ringed Plover seemed easy, too easy to be good, and sure enough ill-fortune stepped in and ruined most of my pictures! The films I was using, being of pre-war stock, had suffered a drop in speed of 400%, and as I had not made sufficient allowance for this all the negatives were badly underexposed.

Another opportunity to return to the marsh came a week later. The shikaris promised me two nests of Ringed Plover and one of Redwattled Lapwing. But Fate still had me in her bad books, and on arrival we found that a pair of Kites had anticipated us by half-an-hour and had eaten every egg. The agitated Lapwings came shouting loudly overhead: *Did-he-do-it? Did-he-do-it? Did, did, did-it.* 'Don't be stupid, of course, he did!', I muttered under my breath. Larks, flying high above this row nearer earth, sang unheeding 'at heaven's gate' and their

'. . . . notes of music fell as sacramental water
Sadly sprinkled on a raging world.'

The robber kites came over again, flying low on reconnaissance, and if I had had a gun I would gladly have shot them. We set out, not very hopefully, to look for more nests but of course we found none. Trouble, which had come a single spy at the end of my last trip, now returned a third time to the attack. In a moment of inattention I fell into soft, clutching mud. The shikari was a long distance away but when my own efforts to extricate myself only made me sink deeper, I called for his help; the man reached me when the sucking mud had reached to my hips, but a little hard tugging however soon got me out.

As I sat unhappily cleaning the mud off my legs Fate suddenly decided to withdraw from further offensive operations and, as though to make up for her previous sour behaviour, now treated me to a sight of the Ringed Plovers' nuptial display. The female was searching for food at the edge of a patch of tall grasses when the male came flying over beating his wings rapidly and calling excitedly, *Sweet-you, Sweet-you, Sweet-you.*[1] When he landed nearby, he fluffed out the side feathers of his breast and with bill extended ran towards his mate as if wishing to drive her away. She trotted off a little distance, and awaited her charging knight who, with bill extended like a lance, came after her at a crouching run. A foot or so away from her, he straightened out of his crouch and drawing himself up to his full height walked the intervening distance doing a rapid goose-step, first raising one leg, then the other, in front of him stiffly; a curious, comical, preposterously cock-of-the-walk performance. The rapidly goose-stepping legs looked, from the side, like two blades of a pair of scissors snipping away at speed. The female, as he came nearer, crouched down slightly, while he advanced waving his legs in the air. Once close he jumped on her back and there, for an appreciable time (perhaps 20 seconds), he stood literally 'treading' her, his feet working strenuously. As he did this her tail slowly came up, and lowering his body he met her, and in a trice the deed was done. Immediately, he was off her back and going away at a run, breast feathers again fluffed out and tail twitching. A second later he flew away.

---

[1] The Handbook of British Birds says of the European race that it 'has a butterfly-like display-flight with long, slow, sweeping wing-beats, often following a zig-zag course'.

I finally succeeded in photographing the Ringed Plover less than a week later; it was a case of 'third time lucky'. On the rocks and shingle at the edge of the Sind River at Woyil Bridge I took a series of pictures of the bird at its nest, all of which turned out well. After I had photographed the Ringed Plover I moved over to my circular hide which had been set up beside the nest of a Redwattled Lapwing. The lazy shikari had omitted to lace up the top of the hide, and as I had already spent five hours taking pictures, I too felt lazy, and so did nothing about it. I had been waiting only 10 minutes when there was suddenly a noise of flapping and a large bird landed on the top rim of my hide; I looked up at the same time as the bird looked in and it would be difficult to say who was the more surprised, because as the bird scuttled away it dropped something heavy with a thud into my lap. The Osprey flew off to a distant tree and looked back ruefully at my tent while I, rubbing the blood off my thigh, picked up a headless two-pound fish from the ground! After such a gift from the sky I decided to suspend further operations—it is well not to ask too much of good Fortune—and with my headless fish tucked underneath my arm I went back to my houseboat in great glee.

CATHAY CINEMA,
SINGAPORE,
October 2, 1956.

LOKE WAN-THO

12. THE DIMORPHIC EGRETS

It has become a common practice among modern systematic ornithologists to unite under the generic name *Demiegretta* Blyth a number of species and subspecies of dimorphic herons, which, apart from their polymorphic appearance (i.e., their individually variable coloration: slate grey, white or pied) and their partiality for a marine habitat, are rather widely different.

They represent at least two different types of birds, and I have already expressed the opinion (*L'Oiseau et la Rev. franc. d'Orn.*, 1949, pp. 10 *et seq.*) that the generic name *Demiegretta* ought to be restricted only to the typical species *D. sacra* (Gm.), the well-known Reef-Heron. Morphologically this species differs from the others now included in the same genus chiefly in the relative proportions of the tarsus and the bill, and also in the nature of the ornamental feathers.

But, besides this unquestionably distinct type of heron, the identity and validity of the other forms of dimorphic egrets erroneously associated with it [in fact much more closely allied to the Little Egret, *Egretta garzetta* (L.)], are more uncertain and have already been discussed in many papers. It is clear that only a close study of their biological relations comparatively with the Little Egret can afford some definite knowledge on the question.

When only skins or stuffed specimens are compared, it seems extremely difficult to differentiate *Egretta garzetta* from white specimens of *E. gularis* (Bosc), *E. asha* (Sykes) (=*E. schistacea*), and still more so from those of *E. dimorpha* Hart. The colour and the proportions of the legs and toes are the same in all of them, the plumage is identical, with the same seasonal changes of ornamental feathers, etc. As already pointed out by myself (loc. cit.), and more recently by Bannerman for the African birds (Birds of trop. W. Afr., VIII, 1951, p. 22), the colour of the bill seems to remain the only appreciable differentiating character (besides some slight differences in size), being black in the always white *E. garzetta* and also in *E. dimorpha,* both in its slate and white phases, against horny brown or even yellowish in *E. gularis* and *E. asha,* in their dark as well as white phases. *E. garzetta* and the white phase of *E. dimorpha* look practically one and the same bird.

Owing to some uncertainty still prevailing in the respective status of *E. garzetta* and the dimorphic egrets which, so close to it morphologically, are said to live in the same countries: *E. gularis* in West Africa, *E. asha* in the Red and Arabian Seas (including the West Coast of India), *E. dimorpha* in Madagascar and East Africa, it would be particularly desirable to study more closely their ecological relationships in the countries where they occur together. The coloured phases of these egrets seem to be found essentially, at least as breeding birds, along the sea-coasts of tropical and subtropical areas, spreading however to the interior in Madagascar and (? perhaps only as seasonal migrants) in West Africa.

In my opinion, these dimorphic egrets represent most probably nothing but local populations of the widely spread *E. garzetta,* adapted to a marine habitat and it seems hardly necessary to recall that their dimorphic character has long been proved by dark and white birds having been observed paired in the same colonies, and even dark and white chicks having been found in the same nest.

Finally there is another difference of generic value between the Reef-Heron *Demiegretta sacra* on the one hand, and the Little White Egret *Egretta garzetta* and its dimorphic allies on the other. In the Reef-Heron the white phase occurs only in the tropical zone of its habitat, the grey phase being the commoner over the rest of its habitat from Japan to New Zealand. The reverse is the case with the Little Egret: its white phase is by far the most widely spread, the grey phase being essentially restricted to the tropical zone.

We do hope that in India, where both *E. garzetta* and *E. asha* commonly occur in suitable places, probably not side by side, it will be possible to study the problem of their relationship more closely. In India, it seems generally believed that *E. garzetta* has more gregarious habits and that *E. asha* is seen more often as a solitary bird. But we must not forget that in the Red Sea[1] area this latter bird is known to breed in more or less extensive colonies of mixed individuals, grey ones and white ones, and the same occurs in the very closely allied *E. gularis* along the coast of West Africa, colonies which are quite similar to those of the Little Egret.

---

[1] Also on the west coast of India.—EDS.

MUSEUM NATIONAL D'HISTOIRE NATURELLE,
RUE DE BUFFON, 55,
PARIS, FRANCE,
October 12, 1956.

J. BERLIOZ

13. BIRD NOTES FROM KUTCH

Maharajkumar Himmatsinhji of Kutch very kindly let me have records from his diary of interesting bird occurrences in Kutch over the last several years, showing how a place like Kutch, situated as it is across a major migration route can always have surprises in store for the regular bird-watcher. With his permission I reproduce some of his interesting observations together with a couple of my own during my visit there in April 1956.

Indian Skimmer: *Rhynchops albicollis*

August 1947 on the Laija Creek west of Mandvi: two birds observed on two subsequent days by M. K. First record for Kutch.

Haircrested Drongo: *Chibia hottentotta*

Seen by M. K. S. Himmatsinhji in January 1948 in the Vijay Villas gardens at Mandvi. Call note very distinct, and through binoculars, the hair-like crest very clearly noted. Tail forks rounded and a high sheen on the mantle. First record for Kutch and possibly for this part of India.

Rednecked Phalarope: *Lobipes lobatus*

Seen by M. K. on Devisar tank north of Bhuj in May 1948, and subsequently also in May 1949. Actively swimming around; and when disturbed, flying a little way to resettle on the water and commence feeding. Chestnut-red on sides of neck and white cheeks very conspicuous. First record for Kutch.

Barn Owl: *Tyto alba*

A live specimen shown at the exhibition held in Bhuj in April 1956. It had been caught at Talvana near Mandvi. This owl not met with in Kutch by Sálim Ali, though it had been noted by Lester.

Blackheaded Bunting: *Emberiza melanocephala*

Noted by M. K. on 9 September and again on the 29th of the same month in 1950. It therefore is also an autumn passage migrant and, as Mr. Sálim Ali mentions, a possible winter visitor. Seen by me in fair numbers on Pachham on 7 April 1956.

Redwhiskered Bulbul: *Otocompsa emeria*

Saw one bird in the Vijay Villas gardens on 11 April 1956. Fifteen of these birds had been released by M. K. S. Himmatsinhji at Mandvi in 1950, and they seem to be quite happy in the shady groves there.

Crow Pheasant: *Centropus sinensis*

This unfortunate but very successful introduction seems to have expanded its range considerably since the Sálim Ali survey, for we noted a bird on the edge of the Banni many miles north of Bhuj.

White Stork: *Ciconia ciconia*

Recorded by Lester in August 1895. Seen by the M. K. on the Ravalpir tank near Mandvi in January 1955.

Grey Drongo: *Dicrurus longicaudatus*

A single bird was shot by M. K. S. Dharmakumarsinhji of Bhavnagar in the Vijay Villas gardens at Mandvi in January (?) 1955.

Pelican sp. ? *Pelecanus* sp.

Eight birds seen by us on the Dhand 11 April 1956.

Glossy Ibis [1]: *Plegadis falcinellus*

Seen by us on the Dhands, 11 April 1956. M. K. S. Himmatsinhji tells me that he has regularly seen these birds in small numbers in winter. Mr. Sálim Ali saw one during the Survey and H. H. the Maharao recorded them on 4 April 1945.

RAJKUMAR COLLEGE,
RAJKOT, SAURASHTRA.

K. S. LAVKUMAR

14. FIGHTING AMONG BIRDS

Last March a Water-Rail was picked up dead on the roadside near a marshy stretch of the River Wey. First thoughts were that it had probably been killed by a passing car. The only discoverable injury, however, proved to be a small hole in the back of the skull. Searching for other possible ways by which it might have met its end, my mind went back to a terrific fight I witnessed between two other members of the Rail family—two Moorhens in fact. A Moorhen is a Moorhen the world over, so although the fight occurred in Southern England it might just as easily have happened in India or anywhere else. Here then is what I wrote down at the time.

'About noon yesterday I looked out of the passage window in time to watch one of the fiercest territorial fights I have ever witnessed amongst birds. The contestants were two moorhens. The snow was nearly six inches deep on the bank of the stream with a till-then unbroken surface so that the forms of the dark contestants were thrown up to perfection against a spotless background. How long the fight had already been in progress I do not know, but from the lengthening pauses, during which they remained interlocked like a pair of in-fighting boxers, they already seemed pretty tired. Their methods of defence and offence were most interesting. Sitting back on the tail, supporting itself from tumbling backwards by half-opened wings, one bird would box and claw at the other, but I am not at all sure that this was intended to injure the other bird so much as to hold it off or alternatively to push it down. For it was obviously with the bill that the main damage was being done. One bird would stretch upwards and with a vicious downward jab attempt to reach the back or top of the other's skull. Once I thought the fight was going to end abruptly for one bird suddenly weakened; its head sagged to one side and it laid itself open to a series of vicious blows which rained on the back of its head, such cruel stabs that I quite expected its complete collapse and death. Then it rallied for a space and almost turned the tables on its opponent, both birds fluttering into the air until they once more became interlocked. Lying back on extended wings with feet intertwined and bills agape they lay for a few moments in the snow, gasping for breath and obviously tired to death but still unwilling to cease their strife. A third bird appeared from the stream and mildly interested approached to within a couple of feet but, probably being the lady in the case, took no part in the contest and, after watching for a minute or two, encircled the combatants and then withdrew whence it had come. The fight recommenced with, if anything, greater ferocity and a fearful pecking bout ensued until one bird—I think it was the one that had previously collapsed—suddenly broke away and turning its back literally staggered with a definite list to starboard to the bank. Its opponent did not follow up its advantage with the energy I expected but lurched after it with lowered head and both disappeared into the stream bed. I thought all was over, but not a bit of it for every now and then a fluttering wing-tip or a vicious down-stabbing bill appeared for a fleeting instant above the bank. My wife suggested I should stop the contest, but I felt that if I did so it would only result in further and fiercer fighting so soon as they had regained their breath. The fight had started over twenty minutes previously when I eventually went to investigate. As I reached the point where the two birds had disappeared I saw nothing; but from twenty yards down stream came a sharp danger note and the noise of floundering wings. The fight had drifted downstream and very probably until my advent was still in progress. So fierce had been the struggle that some ten square yards of the snow's surface was beaten down and criss-crossed with feetmarks and impressions of their bodies, and everywhere bright red stains speckled the churned-up snow; not merely a drop here and there but as if the blood had splashed from the vicious stabs or smeared from blood-stained talons. There were however no feathers nor bits of down strewn upon the snow so the scrabbling feet with their long claws were probably not responsible for much of the gore but, as I have already suggested, the boxing matches are seemingly to hold off and press down the opponent so that the advantage goes to him who can gain sufficient height to rain those dreadful pick-axe blows on the vulnerable top and rear parts of the skull. One or both of these birds must have sustained heavy injuries. How often, I wonder, are these fights for territorial supremacy fights to the death?

---

[1] [Mr. Humayun Abdulali saw a flock of some 60 birds on the island in Hamirsar tank, Bhuj, on 21 and 22 April 1956. On the 23rd they were absent.—EDS.]

HAYBARN,
THURSLEY,
SURREY, ENGLAND,
September 5, 1956.

R. S. P. BATES,
Lt.-Col. I.A. (Retd.)

15. BIRD MIGRATION IN INDIA

Recoveries of Ringed Birds since last Report, *J.B.N.H.S.*, Vol. 51 (3) p. 749

No. of Ring	Date	Name of Bird	Place where Ringed	Remarks (adult or young)	Name of Ringer	Date of Recovery	Reported by	Place where Recovered
3394 ...	25-1-1929	Wigeon *Anas penelope* ♀	Manchar Lake, Sind, *ca.* 26° 40′ N. × 67° 60′ E.		R. B. MacLachlan	29-9-1930	Ring Bureau Dept. of Forest Reservation and Hunting, Moscow.	Omskaya oblast, near Tara, 56° 48′ N. 74° 24′ E.
4148 ...	26-12-1936	Wigeon *Anas penelope*	Keoladeo Ghana, Bharatpur State	Adult	Forest Circle Officer	6-4-1939	do.	The Tajik SSR South of Tashkent.
Moscow D-265213.	5-7-1953	Mallard *Anas platyrhynchos* ♂	Near Zolvinsk (Novosibirskaya oblast), 54° 43′ N. 18° 40′ E.	Adult	Ring Bureau, Dept. of Forest Reservation and Hunting, Moscow	December 1955	Shri G. M. Malik, Director, Dept. Fisheries Jammu and Kashmir State.	Mirgund on the Srinagar-Gulmarg road between 12th and 13th miles.
Moscow D-261592.	19-8-1953	Pintail *Anas acuta* ♂	Astrakhan Sanctuary in the area of the Volga River 46° 14′ N. 49° 2′ E.	Adult	do.	25-29-12-1955	Police Sub-Inspector, Viramgaon.	Nal Lake at Shahpur, Ahmedabad District.
B-11422	8-6-1952	*Platalea leucorodia*	Kyzye–Agachskii Preserve near the town Lenkorahj, Azerbaijanian SSR	Juvenile	do.	1-3-1956	Shri K. N. Jauhari, Secretary, Indian Board for Wild Life.	Village Bela Simri P. S. Khagaria. Shot by Shri Anant Prasad Singh, Mukhia of Bela Simri Gram Panchayat.

BOMBAY NATURAL HISTORY SOCIETY,
114, APOLLO STREET,
July 7, 1956.

EDITORS.

16. THE CHANGING SCENE:

Paucity of Bird Life in Jabalpur (M.P.)

When I first knew Jabalpur in 1904 it was a jungly little station, less than a quarter of its present area; bamboo clumps were everywhere, and game abounded. It was cooler then than now, and frosts were to be expected in the cold season. We do not get them now. Most of the jungle has been cleared for cultivation and building purposes. Rainfall has become uncertain, and subsoil water, and in wells, is lower.

All this change has been coming about gradually during the last fifty years, but it is only during the last four or five that I have noticed the absence of well-known birds. I write only of the Jabalpur Corporation and Cantonment areas, and cannot say what the conditions are outside, as I now rarely go out. But duck, teal and geese, which used to pass overhead, are now not seen. Rosy Pastors were common when silk cotton trees were in bloom. The trees are still here, but not the visitors. Have not seen a single Redstart this cold weather, and only one Grey Wagtail. It was about pittas calling in my garden that I first got into touch with you. They are not here now, and the following have also become rarities: White-eye, Pipit, Treepie, Pied Wagtail, Tailor Bird, Honey-sucker, and various flycatchers, and I am inclined to think that common resident species are fewer in numbers; for example, it is rare to observe a Pied Myna.

Garha,
Jabalpur,
February 26, 1956.

P. V. BEATTY

17. SOLAR ECLIPSE AND ANIMAL BEHAVIOUR

I was interested in the Note at p. 708 of Vol. 53, No. 4, of the *Journal.*

I went to Japan in 1936 to help Dr. Royds, the Government Astronomer at the Solar Physics Observatory, Kodaikanal, South India, in making observations at the time of a total eclipse of the sun.

Until the sun was totally obscured, the darkness was no greater than during daylight with heavy cloud, and such birds and domestic animals as came to my notice behaved in no way out of the common. But as soon as the moon's shadow, dramatically racing across the earth's surface at several hundred miles an hour, reached the place, (the time was about 1 p.m., local time), the darkness at once became such as we know in India during a clear moonlight night near the time of the full moon, and all animal noise and movement ceased forthwith. As, some fifty-five seconds later, the moon's shadow passed away with equally dramatic suddenness, the usual animal noises of early dawn were heard on all sides,—cocks crowing, etc.—and normal movement was resumed. It was very remarkable how, for a period of darkness lasting less than a minute, the animal reaction was the same as for a whole night.

I must therefore controvert the second sentence of your editorial note. It should, I submit, be modified to read that 'at the peak of *any eclipse less than total* the darkness is no greater than on some of the heaviest overcast monsoon days.' If at the place of observation the eclipse is total, the circumstances are wholly different. Your foot note, I may add, even in this modified form, would be relevant to the Note to which it was appended, since that solar eclipse was not total at the place of observation (or, indeed, at any other place).

SCOTT CHRISTIAN COLLEGE,
NAGERCOIL,
TRAVANCORE,
INDIA,
October 17, 1956.

G. H. MARSDEN,
M.A. (Cantab.)
Principal.

18. JUMPING SNAKES

'Mr. D. E. Reuben's note in your issue for April 1956 and his query regarding the ability of snakes to jump reminds me that last year I raised the same question in a letter to *Country Life*.

I was moved to write the letter by an article that appeared in that journal about poisonous snakes in which the author remarked on the agility (not amounting to jumping) of *Echis carinata*. I may say that the following incident, which I described in my letter, elicited several replies all of which seemed to indicate that such action by a snake was beyond the experience of the writers.

On an autumn evening in, I think, 1930, I was dressing for dinner in my quarters at the Delhi Gymkhana Club when my bearer, a most observant and reliable man, suddenly shouted to me from the verandah, "Sahib, jumping snake!" On going out to investigate he pointed to a small snake, tightly coiled in the manner of a viper, on a charpoy on the verandah. He said that when he arrived on the verandah the snake, which was lying on the mat outside the door, had suddenly projected itself, "in one", from the mat on to the charpoy, a horizontal distance of some 8 feet, with a rise of 18 inches.

There was an electric light over the charpoy and to ensure the despatch of the snake before it could escape into the surrounding darkness I shot it with a 12-bore gun, somewhat to the discomfiture of the newar of the charpoy.

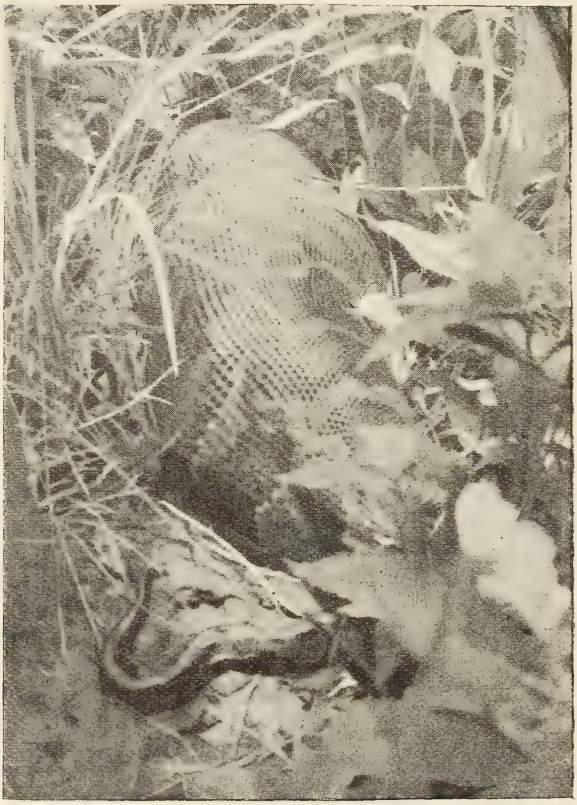
On submitting the mangled remains next day to that well-known authority, the late J. C. Roberts, I was informed that they were those of an *Echis carinata*.

Admittedly I did not witness the incident myself, but I have no reason to doubt my bearer's testimony, nor does it seem impossible that the muscular power of a coiled snake should enable it to project itself through the air for a short distance, especially as it would have an excellent "take-off" from the rough door-mat.'

6, ARTILLERY MANSIONS,
WESTMINSTER,
LONDON, S.W.-1,
August 28, 1956.

H. A. N. MEDD

19. A PYTHON'S MEAL



The above photo was taken by U Maung Gale, Divisional Forest Officer, Shwebo, on 20th August 1955; shortly after the Python had swallowed a small thamin in Kyaikthin Wild Life Sanctuary.

25, Inyamyaing Road,
University P.O.,
Rangoon,
April 12 1956.

TUN YIN,
B.C.S., (Retd.)

20. DHAMAN OR RAT SNAKE (*PTYAS MUCOSUS*) DRINKING MILK

As it is often stated that no snakes drink milk, the following may be worth recording. This happened at Kheri in the U.P. during the monsoon in 1923:

The milk-drinking Dhaman used to come from the scrub jungle near the bungalow, where we would have waiting for it a saucer of milk near our chairs in front of the verandah. The scrub jungle was quite 20 yards away. Regularly in the evening we would place the saucer of milk in the same place and regularly the Dhaman would emerge from the scrub and come along and drink the milk. While it approached us, my friend and I had to remain motionless and silent, not even attempting to turn our heads or move a hand. But our eyes were free to watch our guest who after emptying the saucer, returned as silently and gracefully as he came. It was a delightful entertainment.

We had trained the Dhaman to come closer and closer, first by placing the saucer on the edge of the scrub, then nearer and nearer to the bungalow, eventually close to where our chairs would be put in front of the verandah.

HAPPY VALLEY,
MANDERSTON P.O.,
NATAL, S. AFRICA,
August 20, 1956.

J. E. C. TURNER,
I.F.S., (Retd.)

21. STRANGE ACCIDENT TO A FROG (*RANA BREVICEPS* SCHNEID.)

On 15th July 1956 in the cistern outside Cave 3 at the Kanheri Caves, Salsette, Bombay, I saw a foam-nest of *Rhacophorus maculatus* stuck in the angle of two vertical rock walls, a few inches above water. A large frog was seen with his head inserted into the bottom of the nest. On attempting to pick him off, the top of his snout was found to be so firmly attached to the nest, that the whole mass had to be pulled off together. The frog was an adult male of *Rana breviceps*, in an extremely weak condition. He had apparently poked his nose into the nest in an attempt to climb the wall and would no doubt have died in this curious position. The stomach was empty and the guts contained remains of vegetable matter.

MESSRS. FAIZ & CO.,
75, ABDUL REHMAN STREET,
BOMBAY-3,
October 29, 1956.

HUMAYUN ABDULALI

22. THE SPAWNING OF CARPS

I have only now read Dr. Goldschmidt's letter together with Dr. Kulkarni's reply published on page 634 of the December 1954 issue of the *Journal*.

Although this correspondence specifically refers to *Labeo rohita* a similar question has been arousing my curiosity for some time. I refer to the spawning of *Barbus tor khudree* in the Periyar River above the Lake.

The SW. Monsoon rains at the end of May certainly induce these fish to move up the river from the lake, and spawning takes place between July and August. The river is also in flood at the beginning of the NE. Monsoon in October and early November. During November and early December I have taken large numbers of both clean and gravid fish. This at any rate would indicate that the Periyar Mahseer spawns between June and December, seven months of the year, which is considerably more elastic than the period June-August mentioned by Dr. Kulkarni.

It may be that this can be explained by the rainfall of the Western Ghats, but when Dr. Goldschmidt deduces that fish with 'blood-red discoloration near the vent, and orange spots on the gill covers' had already spawned, I wonder whether this is necessarily so. For mahseer with this spawning livery taken by me in early December have been full of roe or milt. Whether these fish are unsuccessful spawners similar to salmon 'baggots' I must leave for Dr. Kulkarni to say.

Theoretically, it would seem unnatural for a fish to spawn when rivers are in spate, for this must inevitably give rise to a big waste of ova.

I think it likely in the circumstances perhaps peculiar to the upper reaches of the Periyar River that fish move up from the lake with the first monsoon floods and that there are a number of early spawners in June, July and August. A proportion of this early run of fish may not become sexually mature until September and October when they would spawn at the same time as the later, or second run of fish after the main flood months.

During November, gravid fish have been taken by me between one and twelve miles from the point where the river joins the lake, and during the same month I have caught a number of fish in spawning livery and full of roe entering the river from the lake. It is evident that a certain amount is still to be understood about the spawning habits of the masheer here if not of the Cyprinidae as a whole.

Bonami Estate,
Fairfield P.O., J. D. LOVATT
U.S.T.C.,
March 10, 1956.

[Dr. C. V. Kulkarni, Director of Fisheries, Bombay State, to whom the above was shown, comments as follows:

'Mr. J. D. Lovatt states in his note "The Periyar Mahaseer spawns between June and December, seven months of the year, which is considerably more elastic than the period June-August mentioned by Dr. Kulkarni". Mr. Goldschmidt's note and my comments on it referred to the spawning of the major carps, viz. Catla, Rohu and Mrigal only. Mahaseer is not conventionally included in this group of the major carps. As such, Mr. Lovatt's comparison of the spawning season of major carps with that of the Mahaseer is not quite relevant.

Dr. Hora,[1] Dr. Hamid Khan[2] and others have pointed out that the Mahaseer spawns more than once during the year. Dr. Hamid Khan found that the Mahaseer in the river systems of Northern India spawn first in January and February; secondly in May and June when the snow melts and rivers are swollen, and thirdly from July to September when the rivers are flooded with monsoon rains. Thus, there is a strong evidence that the period of spawning of the Mahaseer is an extensive one, which is unlike that of the major carps mentioned above. It is quite possible, therefore, that the Mahaseer in the Periyar Lake may be breeding in the period June to December.'—EDS.]

---

[1] Hora, S. L. (1945): *Proc. Nat. Inst. Sc. Ind.* Vol. XI.

[2] Hamid Khan (1939): *JBNHS.* Vol. 41.

23. ON THE OCCURRENCE OF MUMMIFIED EELS IN THE INTERNAL ORGANS OF *POLYDACTYLUS INDICUS* (SHAW) AND *POMADASYS* SP.[1]

Accidental inclusions of foreign objects in the body cavity of fishes have been reported by various authors. These include mummified specimens of sand eels (*Ammodytes* sp.) and pipe-fish on the walls of the abdominal cavity of Cod and Haddock (Atwood, 1857), while a variety of other objects like vertebral column of fish, fish hooks, knife and even hermit crab have been found in the body cavity and visceral mass of cod, haddock and pollock (Atwood, 1859, 1869; Collins, 1884; Barret, 1885 and Williamson, 1911). Earlier literature has been reviewed by Gudger (1922). Deraniyagala (1932) found some mummified remains of *Ophichthys apicalis* (Benn.) in the body cavity of large percoid fishes. Smith (1953) observed that *Ophisurus serpens* (L.) has the habit of piercing into the body of other fishes.

During an investigation of the biology of some of the trawl fishes landed at Bombay, certain hard, flattened bodies, apparently resembling small eels were found embedded in the mesenteries and other internal organs of *Polydactylus indicus* and *Pomadasys* sp. On closer examination of the material in the laboratory they were found to be mummified eels, probably belonging to the genus *Ophichthys*. Though the material was shrunk, stiff and to some extent distorted in shape, it was in a remarkable state of preservation which rendered identification possible. The following table (page 200) gives the details of observations.

All the fishes that harboured these eels were closely examined to find if there existed any wound or mark on the walls of the stomach through which they might have entered the body cavity. No such wounds were visible, nor was there any apparent sign of ill-health in any of them.

Coming to the question as to how these eels may have reached such situations normally inaccessible to them, Barret (1855) explains that they might have been swallowed by the host and that with the help of their pointed jaws they might have penetrated the walls of the stomach and worked their way into the body cavity. Though Williamson (1911) is satisfied with this explanation as far as pointed objects are concerned, he thinks that it is hardly the way a hermit crab might have reached the body cavity. The crab, he thinks might

---

[1] Published with the permission of the Chief Research Officer, Central Marine Fisheries Research Station, Mandapam.

TABLE

Date	HOST			MUMMIFIED EELS.		Location.	Remarks.
	Species.	Length cm.	No. of specimens.	Length cm.	Colour.		
19–12–'52	*Polydactylus indicus* (Shaw).	115·4	1	9.9	Brownish.	Abdominal mesenteries	Shrunk.
8–11–'52	,,	106·7	1	13·4	Black.	Fringe of right ovary.	Flattened and dried.
,,	,,	106·3	1	10·2	Grey.	In between the hepatic caeca.	Round and well preserved.
			2	11·6	Grey.	Abdominal mesenteries, tail piercing liver.	...
22–12–'52	,,	113·4	1	8·5	Brown.	Mesentery.	Crumpled.
			2	11·2	Brown.	Hepatic caeca.	...
			3	11·6	Blackish.	Mesentery.	...
			4	7·9	Dull Yellow.	Left ovary.	Very well preserved, Possibly recent inclusion.
			5	9·2	Brown.	Do.	...
			6	11·3	Deep Brown.	Mesentery to liver.	...
1– 2–'53	,,	108·6	1	12·1	Black.	Do.	Crumpled to an earthy crust.
			2	10·3	Grey.	Right ovary.	Round and well preserved.
2–11–'53	*Pomadasys* sp.	54·3	1	11·6	Greyish yellow.	Right ovary and visceral mass.	Well preserved. Portion in between ovary and visceral mass slightly decayed.

have passed through the walls of the stomach at a point where the tissue was weakened, possibly by the attack of some intestinal parasites. So far as the present observations are concerned the earlier explanation given by Barret (op. cit.) seems to hold good, firstly because of the very pointed snout of these eels and secondly because eels often formed an item of food of the adult *P. indicus* wherein this phenomenon was commonly observed (Mohamed, 1955).

My grateful thanks are due to Dr. N. K. Panikkar for his encouragement and guidance.

CENTRAL MARINE FISHERIES
RESEARCH SUB-STATION,
WEST HILL, KOZHIKODE-5,
September 5, 1956.

K. H. MOHAMED

REFERENCES

Atwood, N. E. (1857) : *Proc. Boston Soc. Nat. Hist.*, **6** : 176.
— — — (1859) : ibid, **7** : 4.
— — — (1868) : ibid, **11** : 364.
Barret, W. H. (1885) : 3rd. Ann. Rep., Fish. Bd. Scotland, Appendix F. **5** : 70-72.
Collins, J. W. (1886) : *Bull. U.S. Fish Comm.*, **6** : 381-383.
Deraniyagala, P. E. P. (1932) : *Spol. Zeyl.*, **16** (3) : 355-356.
Gudger, E. W. (1922) : *Jour. Amer. Museum Nat. Hist.*, **22** : 452-457.
Mohamed, K. H. (1955) : *Ind. Jour. Fish.*, **2** : 164-179.
Smith, J. L. B. (1953) : The Sea Fishes of Southern Africa.
Williamson, H. C. (1911) : 28th. Ann. Rep., Fish. Bd. Scotland, **3** : Scientific Investigations, 62.

24. OCCURRENCE OF THE ECHIUROID WORM *IKEDELLA MISAKIENSIS* (IKEDA) IN INDIAN WATERS (GULF OF KUTCH)

(*With a text figure*)

During a survey of the low tide belt of Pirotan Island, 10 miles off Jamnagar, we came across an interesting Echiuroid (a bonellid), *Ikedella misakiensis*[1] (female) which we believe has not so far been reported from Indian Waters, but only found within the vicinity of Shimoda Marine Biological Station, Japan! The specimens collected were fairly large and seem to differ from that described from Japan in certain features, especially in the position of the nephridiopore.

The survey was made on 11 and 12 June 1956, and *Ikedella* was discovered on the 11th morning. An interesting feature about the animal's activity is its relationship with the temperature of the surrounding water. It extends its proboscis only when the water gets sufficiently warm. It was after nearly 2 hours of waiting on those coral rocks that the worms were seen to extend their proboscis into the water. It was observed that the body of the animal is always placed slightly oblique inside the rocks. The rocks had to be broken before the animals were removed entire. Even during low tide these worms were completely submerged under water.

---

[1] Synonym, *Parabonellia*.

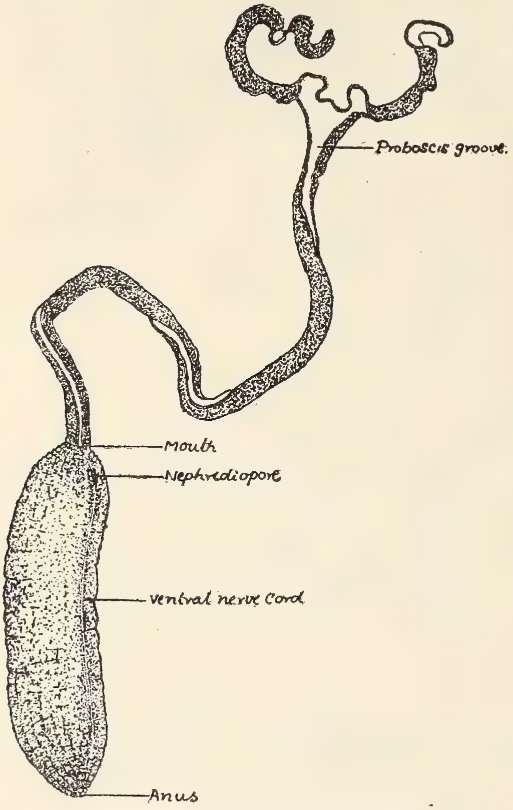


Fig. *ikedella misakiensis* (Ikeda)
$\frac{2}{3}$ natural size

Description

The colour of the body is pale brown. It is semi-transparent, with a longitudinal white line traversing the body from the anterior to the posterior region, and indicates the position of the ventral nerve cord. The nephridiopore opens in the anterior region of the body on a papilla placed on the left of the mid-ventral line.

The length of the worm from the tip of the proboscis to the anus ranges from 5.6″ to 9.3″ (fig.). The body length ranges from 1.6″ to 3.5″ and is slightly bent ventrally. The body is almost cylindrical and sausage-shaped. The proboscis is ribbon-like, grooved on the ventral side and is dark violet in colour. The outer margin of the proboscis, throughout its whole length, extends on either side as a thin white border which becomes more prominent in the bifid region.

A detailed study of the ecology and anatomy of the worm is in progress and will be published later.

We would like to express our thanks to the Director, Fisheries Department, Saurashtra Government, for the help rendered by his staff during our stay in Pirotan island. Our thanks are also to Dr. Norman Tebble (Annelida Section) of the British Museum for kindly identifying the specimen.

P. W. GIDEON, P. K. B. MENON,
S. R. V. RAO[1] & K. V. JOSE

Department of Zoology,
Birla College of Science,
Pilani (Rajastan).

Reference

Sato, Hayao (1935): *Parabonellia misakiensis* (Ikeda) found in the vicinity of the Shimoda Marine Biological Station. *Annoto. Zool. Japan.* **15** (1): 142-144.

---

[1] Government of India Research Scholar (Senior).

25. THE UNUSUAL RESISTANCE TO STARVATION OF *SACCHARICOCCUS SACCHARI* (CKLL.)

The sugarcane mealy bug *Saccharicoccus Sacchari* Ckll. is becoming increasingly important in the sugarcane growing areas in the Nizamabad district of Andhra State. A comprehensive account of its status on sugarcane has been given by Puttarudriah (1954).

On 4-7-1956, three medium-sized gravid female mealy bugs were taken out from the leaf sheath of a sugarcane plant and put in a small specimen glass tube plugged with cotton wad. 28 numbers of pinkish coloured crawlers were observed on 11-7-1956. By oversight the tube was stowed away without any food supply either to the crawlers or to the female mealy bugs. On 6-8-1956, when the tube was accidentally taken out, the crawlers were found clustered together between the cotton wad and the inside of the tube. No sooner was the wad taken out, than all the crawlers were observed to move about briskly. The female mealy bugs were, however, dead. This shows the remarkable tenacity of the crawlers of the mealy bug: to live without food and in an unnatural environment for such a long time.

Govt. Agri: Research Station,
Rudrur P.O.,
Nizamabad Dist., Andhra.

D. V. MURTHY

Reference

Puttarudriah, M. (1954): *Ind. J. Ent.*, **16** (1): 1-10.

26. SOME INTERESTING OBSERVATIONS ON THE ROYAL CHAMBER IN THE MOUND OF THE TERMITE *ODONTOTERMES REDEMANNI* (WASMANN)

Termite mounds and their peculiarities have been described by different authors[1—4] and it is believed that generally the royal chamber of the mound lies below the level of the ground surface. But some exceptions have been recorded about the royal chamber, in a mound of the termite *Odontotermes redemanni* (Wasmann) at Jhargram. The mound, about 15 in. in height, was peculiar in having the royal chamber located superficially, about 5 in. below the upper dome of the mound. Curiously, the chamber occupied the north-west sector of the mound and not north-east, a position that has been described as 'invariable' by Deoras[1]. The queen in the chamber was however, lying parallel to the magnetic meridian, i.e., in the North-South direction.

It may be pointed out that Mukerji and Mitra[3] recorded two abnormal positions of the royal chamber at the Maithan dam area only during rainy seasons. The present note records the observation in the summer (April) 1955, and suggests that certain bio-ecological conditions, rather than purely environmental conditions, govern the position of the royal chamber in the termite mounds.

NATURAL HISTORY SECTION,
INDIAN MUSEUM,
CALCUTTA.

B. BANERJEE

REFERENCES

[1] Deoras, P. J. (1949): *Current. Soc.* **18**.
[2] Gupta, S. D. (1953): *Proc. Nat. Inst. Sc. India,* **19**: 5.
[3] Mukerji, D. and Mitra, P. K. (1949): *Proc. Zool Soc. Bengal,* **2**: 1.
[4] Vishnoi, H. S. (1955): *Proc. Ind. Sc. Cong.* Part 3.

27. SOME COMMON TERMITES OF CALCUTTA

Termites are quite common in Calcutta throughout the year and particularly at the onset and during the rainy season, when they make their appearance in large numbers. Although all the castes of a particular species are not available at one time and at a particular place, a general idea about them can be had from collections made in the different parts of the city. In the present communication, a list of these termites, with short notes about the conditions under which they were found, is given. The collections were made in the months of June–July 1956.

As the classification of the termites is controversial and since Holmgren's (1917) general treatment on the Indian termites requires some important modifications, I have mainly followed Banks and Snyder's (1920) classification, as enumerated by Imms (1951). The genus *Termes*, however, has been omitted, since it shows remarkable morphological similarities with the genus *Odontotermes*, and the two genera have been considered together as the genus *Odontotermes*. All the species mentioned here belong to the Family Termitidae.

Family TERMITIDAE

Clypeus with median eye. Frontanelle present.

Genus ODONTOTERMES. Holmg.

Antennae 16–17 jointed.

1. **O. redemanni** Wasm.

Head of the soldier oval and narrowed anteriorly. The tip of the jaws bent in, and above the left jaw there is a slight projection. This is the most common mound-building termite of Bengal. Nests are quite common in certain suburbs of Calcutta. Two types of workers (Major and Minor) present in the collection.

2. **O. obesus** Ramb.

Head rectangular. Left jaw with tooth in the middle. Large number of specimens (both workers and soldiers) obtained from the compound adjacent to the Zoology Dept., University College of Science, Calcutta. They were found attacking a cut piece of coconut pulp. Two types of workers and one type of soldiers present in the collection.

3. **O. heimi** Wasm.

Major workers collected in large number from an old wooden frame work. Soldiers collected from another place. Workers and soldiers quite common at Jhargram.

4. **O. horni** Wasm.

Stout mandible with pretty big tooth. Workers and soldiers collected from a wooden shelf.

5. **O. obscuriceps** Wasm.

Left mandible bent basally. Soldiers obtained from an old house at Calcutta.

Genus COPTOTERMES Wasm.

Frontanellae towards the anterior end, large and open.

1. **C. heimi** Wasm.

Head narrow at the anterior end and rounder at the hinder end. Soldiers and workers collected from under a log of wood.

Genus MICROCEROTERMES Silv. (?)

Both mandibles equally bent concave on inner side. Serrated internal edge.

1. **Microcerotermes** sp.

Jaws a bit smaller than the size of the head of soldier. Specimens (mainly soldiers) collected from the old stem of a tree.

Genus MICROTERMES Wasm.

16 jointed antennae. Soldiers smaller than the workers.

1. **M. heimi** Wasm.

Small mandibular tooth. Workers and soldiers collected, while attacking a wooden shelf containing books. They were preparing tunnels within the shelf.

2. **M. obesi** Holmg. (?)

Specimens, mainly workers, collected while coming out of a hole, in the compound attached to the Zoology Dept., University College of Science.

Genus LEUCOTERMES Silv.

Rectangular head. Pronotum strongly grooved anteriorly.

1. **Leucotermes** sp.

Antennae 14–15 jointed. Workers collected from debris in Garia, a few miles away from Calcutta.

Genus EUTERMES Mull.

Mandible very small. Head with frontal tube.

1. **E. horni** Wasm.

Vertesae and Frons in one line. Specimens obtained from old wooden debris.

It should be noted that of all the termites mentioned above, the genus *Odontotermes* is the commonest in Calcutta, not only in the particular period referred to above, but throughout the year. The insects are very common in the older houses of Calcutta, and their number increases during the rainy season.

My thanks are due to Prof. D. Mukerji, Reader in Zoology, University of Calcutta, for giving me permission to work in the Entomological Laboratories, Zoology Dept., University College of Science, Calcutta.

NATURAL HISTORY SECTION,
INDIAN MUSEUM,
CALCUTTA,
August 3, 1956.

BARUNDEB BANERJEE

REFERENCES

1. Banks, N. and Snyder, T. E. (1920) : *U. S. Nat. Mus. Bull.*, **108**.
2. Holmgren, K. and N. (1917) : *Mem. Dept. Agri. India*, Entom. Ser, **5**.
3. Imms, A. D. (1951) : Text Book of Entomology, London.
4. Wasmann (1903) : *Zool. Jahrb. Syst.* **17**.

28. NOTES ON THE COMMON BLACK GARDEN BEETLE *BASILIANUS NEELGHERRIENSIS*

In January last, I again found one of these beetles on our garden path (Lovedale, Nilgiris). They are quite common about here, but I have never been able to find out what they would eat, as they are generally found 'taking a walk' on the garden paths. But as I had been told that it *might* belong to the Carabidae family which is carnivorous, I thought I would try if this one would eat rather raw cooked meat cut into quite small pieces. When it had settled down in its new quarters, I found that it began eating the meat quite a lot.

In strange surroundings, i.e., in captivity, they are very quick to sense, or hear, any 'foreign' approach, and will 'freeze' at once. So that it is not easy to observe them eating, but I found that by approaching *very* quietly, and staying *very* still, I could observe it when it was quite definitely eating the meat.

This beetle I sent to the Bombay Natural History Museum for indentification, and was told that it was not of the Carabidae family, but was *Basilianus neelgherriensis* of the family of Passalidae. It appeared to be something new to find that they would eat meat, so when I again found one of these beetles in the garden about three weeks ago (August) I thought I would experiment once more. This one took longer to settle down ; either he was already well fed when I found him, or he had had some definite journey in his mind ! It was at least two days before he would touch any meat, I tried him first with raw meat, but nothing would tempt him. Two days later, however, he quite definitely ate the half-cooked meat which this time I had put in his box all in one piece, about one inch long and a quarter inch broad. Though this time I did not observe the beetle actually eating, the meat's surface clearly showed marks all over it of having been well bitten.

Having once more proved to myself that these beetles will eat meat, at least in captivity, I released *Basilianus neelgherriensis* back into the garden.

I should be very grateful for any remarks these notes of mine may produce from others, and would like to know what is this beetle's natural food. I now know they are wood-boring, so suppose they do a certain amount of harm; but perhaps there is some good they also do.

c/o Miss Heath,
Lovedale P.O., (MISS) M. E. WOLFE MURRAY
Nilgiris,
September 3, 1956.

29. *TARACHE NITIDULA* F., A SEMILOOPER PEST ON COTTON IN SOUTH INDIA

(*With a plate*)

Introduction

Cotton is one of the important cash crops grown extensively in South India. Like any other crop it is also subject to the attack of a number of pests. Among them three semiloopers figure prominently, namely, *Cosmophila indica* G., *Acontia graellsi* F., and *Tarache nitidula* F. Of the three loopers, in some years *Tarache nitidula* F. assumes the status of a major pest defoliating the leaves. It has a wide distribution throughout the plains of Southern India. Fletcher (1914) has recorded the occurrence of this pest on *Calotropis gigantea* besides cotton. Hussain (1925) has reported it on Punjab Cotton with another species of *Tarache* namely, *notabilis,* during the months of May and August. Taylor and Chopra (1921) have classified it as a major pest of cotton in the Transvaal and the Punjab, effectively controlled by light traps. Lesne (1931) also is of opinion that it is a major pest of cotton. Ramakrishna Iyer (1940) reckons this insect as a sporadic local pest appearing now and then on cotton doing extensive damage.

A severe infestation was noted in the Central Farm, Agricultural College, Coimbatore during 1955 which gave an opportunity to pursue the life-history of the pest as very little is known on its bionomic and control aspects. The following is a short account of the observations made on this pest at Coimbatore.

The Moth: (Fig. 4).

Hampson (1910) has given the following description:

> 'Head and thorax silvery white; palpi above, antennae, forelegs and the tarsi brownish; abdomen white. Fore-wings silvery white; an oblique quadrate olive-brown patch from costa near base to median nervure and a triangular patch on middle of costa; the terminal area broadly olive-brown shading to purple-grey with the indistinct dark curved post-medial line near its inner edge commencing in the white sub-terminal line with very short streaks on the veins from it to a fine white line just before termen enclosing a series of spots the spot above tornus being blackish; cilia white tinged with brown at tips. Hind-wing white, the veins of terminal area tinged with brown the termen suffused with brown, narrowing to tornus or confined to apical area; cilia white with a brown line through them towards apex.'

Life History:

The moths copulate after a day of emergence, and the female lays 30 to 40 eggs singly on the surface of the leaves. The eggs hatch out in the course of three days. The caterpillars are very active and move on the plant in a looping manner. They feed on the tender leaves biting the edges of the leaflets. There are four moults during the larval stage. The caterpillar feeds voraciously and becomes full grown in 20 to 22 days. The full-grown caterpillar undergoes a drastic contraction in size just before pupation. It pupates in the soil without any elaborate cocoon formation. The pupal period varies from 12 to 15 days. Thus, the whole life-cycle from egg to adult takes 33 to 37 days.

Egg:

The egg is circular in shape, greenish in colour and measures 0.577 mm. (Fig. 1*b*). The egg period varies from 3 to 4 days.

Larva: *1st Stage: (2a)*

Newly hatched larva about 2 mm. long, with prominent head, brownish black in colour; body slender and blackish; the intersegmental area blackish white. Prolegs confined to 5th, 6th and 10th segments of the abdomen, the anterior ones being inconspicuous. The larva moves actively in a looping fashion.

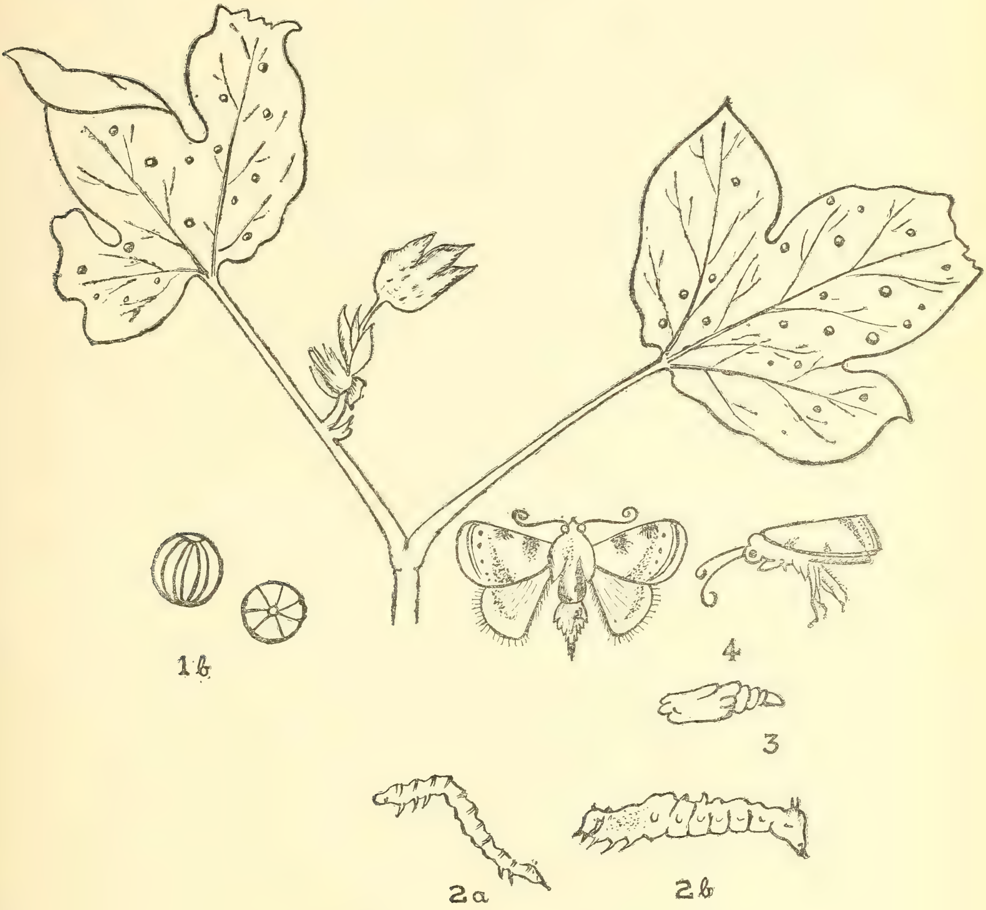
2nd Stage:

Length about 6 mm. Body orange coloured with a number of white spots; second and third thoracic segments with a smoky black patch on the dorsal side and the last anal segment with two distinct white spots. Each segment provided with four black tubercles; the anal segment raised in the form of a hump and provided with 2 orange-coloured tubercles on the summit. Paired prolegs three in number, and orange coloured with black crochets; thoracic legs whitish yellow in colour.

3rd Stage:

Length about 1.6 cm. Body including head, thorax, abdomen and prolegs chocolate brown with number of black and white spots, some of the black spots on the thoracic and abdominal region being located on raised tubercles; hairs on tubercles black; two whitish patches seen prominently abutting the dorso-median line on the third

LIFE HISTORY STAGES OF TARACHE NITIDULA F. ON COTTON



EXPLANATION TO THE PLATE.

1 b	EGG MAGNIFIED
2 a	YOUNG CATERPILLAR
2 b	FULL GROWN CATERPILLAR
3	PUPA
4	ADULT

thoracic, 1st abdominal and anal segments. Spiracles distinct as black oval patches.

4th Stage:

Larva pink coloured and about 2 cm. long. Body smooth and provided with brick red spots, a pair of them each on the head, on the thoracic segments as well as 1st, 2nd, 3rd and 8th abdominal segments.

5th (Final) Stage: (Fig. 2b)

Length about 2.4 cm., body very stout, smooth and ashy grey, greenish, yellow and green; head-shield mottled in appearance. Thoracic segments show progressive increase in size with prominent swellings on the first and second. Second, third and fourth abdominal segments smaller in size with a prominent hump situated dorsally on the eighth segment. The total larval period varies during July to August from 20 to 22 days.

Pupa:

Pupa naked dark brown, oval and measures 5 cm. in length. Pupal period during late July to August varies from 10 to 12 days (Fig. 3).

ALTERNATIVE HOST PLANTS

This caterpillar has a number of alternative host plants namely, *Calotropis gigantea, Hibiscus esculentus* and *Abutilon indicum* besides being specific to cotton crop.

REMEDIAL MEASURES

Since this larva, of late, appeared in a virulent pest form sporadically, a small scale insecticidal trial was conducted in the Central Farm area. Four treatments, namely, sprays of BHC 0.1%, DDT 0.1%, Aldrin 0.1% and Dieldrin 0.1% were tried on the infested plants. Four heavily infested plants were selected for each treatment and the population of caterpillars on 5 leaves per plant was counted before and after treatment. The following results were obtained (Table I).

TABLE 1

Treatments	*Tarache nitidula* F.		Treatment and population counts.		
	Number of leaves examined per plant	Population before treatment	Population after treatment in		Percentage of reduction in population.
			24 Hrs.	48 Hrs.	
1. BHC 0·1% ...	5	12	4	0	100%
2. DDT 1% ...	5	14	9	7	55%
3. Aldrin 0·1% ..	5	10	6	4	60%
4. Dieldrin 0·1% ...	5	16	8	6	63%
5. Control ...	5	12	10	10	Nil.

From the trials it is evident that BHC 0.1% can effect a complete mortality of the caterpillars within 48 hours after treatment. Next in order of efficacy are Aldrin and Dieldrin respectively. In the trials conducted, spraying was adopted in preference to dusting as the former alone was found practicable for dealing with the caterpillars which usually remain on the underside of the leaves.

ACKNOWLEDGEMENT

The author is deeply indebted to Sri K. P. Ananthanarayanan B.A. (Hons.), Government Entomologist, for his kindness in going through the paper and making valuable suggestions.

MADRAS AGRICULTURAL DEPARTMENT. S. VENUGOPAL,
B.SC. (Zool.), B.SC. (Bot.), M.SC.

BIBLIOGRAPHY

Chopra, R. L. (1928). Annual Report of the Entomologist to the Government of Punjab, Lyallpur, 1926-27. Rep. Dept. Agri. Punjab 1926-27, **1**: 43-69.

Fletcher, T. B. (1914): South Indian Insects: 132.

Hampson, L. H. (1910): Cat. Lep. Phal. Brit. Mus., **10**: 768.

Hussain, M. A. (1925): Annual Rept. of the Entomologist to the Government of Punjab, Lyallpur, 1924. Rept. Dept. Agri., Punjab, **1** (2): 55-90.

Lesne, P. (1931): Coup d'oeil surles pronapaux ennemis ducotonieram Mozambique. *Rev. Bot. Appl.*, **10**: 781-791.

Ramakrishna Iyer, T. V. (1940): Hand-book of Economic Entomology Supt. Govt. Press, Madras. 241.

Taylor, J. S. (1927): A note on some African Lepidoptera of economic importance with special reference to eastern Transvaal. *Ent. Rec.*, **39** (10): 141-144.

30. PARTIAL EMERGENCE OF THE IMAGINES OF DRAGONFLIES (ODONATA) DUE TO THE ABSENCE OF A HOLDING PLACE

(*With two figures*)

While engaged in a study of the Biology of Dragonflies of Ramanathapuram District (South India) in an attempt to elucidate the conditions attending the emergence of the imago, I came across interesting cases of partial emergence of the imagines and subsequent drowning of the latter, due to the absence of a holding place in the laboratory experimental jars, where several dragonfly nymphs were kept for observation and study. Since there is no record of a similar observation, it was felt that this interesting case is worthy of recording. In view of the importance of the dragonflies in the biological control of mosquitos (adults and larvae), the present observation at this critical stage in the life-history comprising of a shifting over from aquatic to aerial mode of life will be of considerable interest.

Thirtyseven nymphs belonging to the genera *Pantala*, *Tholymis*, *Tramea*, *Orthetrum* and *Anax* were kept in a glass jar of 2′ × 1′ × 1½′. The jar was half filled with clear pond water free from reeds, weeds and other usual resting structures for the nymphs, to note whether the nymphs could metamorphose into adults without a suitable object for gripping and if the emergence could be postponed even after the completion of the metamorphosis. The smooth inner surface of the glass jar did not permit a firm hold for the legs of the nymphs. It was noticed that, whereas, in the control bowls which contained partially submerged reeds, normal metamorphosis took place and the adults emerged out of the nymphal cases leaving behind the exuviae above the level of water, in the present instance the emergence of the imago was partial. In case No. 1, (nymph of *Pantala*) it will be seen that only a part of the head and thorax of the imago emerged through the 'crack' in the nymphal case while the rest of the body could not be pulled out which remained within the case. In the second case (nymph of *Tramea*) the emergence was found to be still more advanced but incomplete. The entire head, thorax

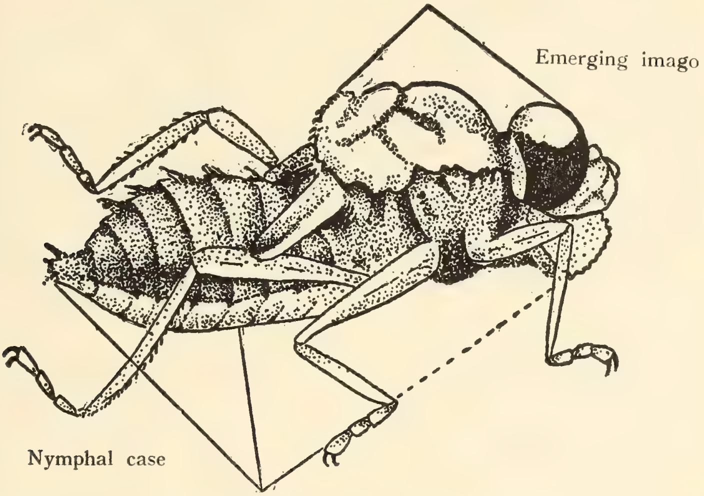


Fig. 1. showing the partial emergence of the imago of *Pantala*.

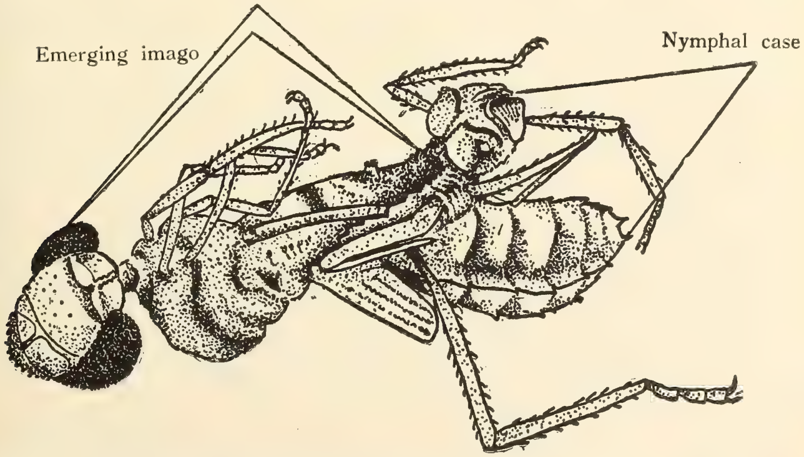


Fig. 2. showing the unsuccessful emergence of the imago of *Tramea*.

and the three pairs of legs emerged out of the nymphal case, but the wings and the abdomen could not be pulled out by the emerging insect, obviously due to the absence of a firm substratum, on which the nymph could firmly hold, to pull the wings and the abdomen. It will be of interest to note the statement of Corbet (1955), in the light of the present observation. He states, 'It is worthy of mention that, after metamorphosis has been completed, it is probable that emergence can be postponed for a considerable time. . . . . This ability to postpone emergence for a considerable period until conditions become favourable might well be of adaptive significance.' However, the present observations indicate that (1) the duration of nymph cannot be extended beyond a certain period. Instead of postponing the emergence, the imago while still partially encased in the nymphal cover, gets drowned, in the attempt to emerge, and that (2) it fails to emerge successfully in the absence of a suitable foot-hold. The present observation, therefore, suggests that one of the essential requisites for the successful emergence is the availability of a suitable substratum on which the nymph could hold fast.

Thanks are due to Dr. N. Balakrishnan Nair for suggestions and help in the preparation of this note, and Prof. Samuel Raj for facilities given.

DEPARTMENT OF ZOOLOGY,
ALAGAPPA COLLEGE, D. R. KRISHNAN
KARAIKUDI,
October 14, 1956.

REFERENCE

Corbet, Philip (1955): *Proc. R. ent. Soc. of Lond.*, (A) **30**: 115-126.

31. HESPERIIDAE OF THE KHASI AND JAINTIA HILLS

Brigadier Evans in his Catalogue of the Hesperiidae of Europe, Asia and Australia frequently mentions the Khasi Hills or the Naga Hills and Manipur but often merely records Assam, so a list for the Khasi and Jaintia Hills is just worth making. The collectors working under Tytler in the Naga Hills and Manipur between 1911 and 1913 took many Hesperiids now in the British Museum (Natural History), but those procured by others from the Khasi Hills, nearly all from the Cherra area, were evidently only a small part of the general takings of butterflies, as one finds many species represented from the Khasi Hills by only one or two examples in the British Museum. One can therefore conjecture that a few more species do occur but have not been taken, though I have only one such in my collection. This was meagre when I left India; subsequent procurement from the Shillong dealer resulted in large numbers but most of them of a few common species. The obtaining of a few species not known to exist is not worth heavy and expensive slaughter. The list is made binomial for compression; trinomials indicating the Assam subspecies can be found in Evans's book. Abundance or rarity can be judged by the numbers recorded for Assam generally, and of the Khasi Hills particularly, in Evans, but I have noted VC, C or NR for some species which I have got in numbers sufficient for such recording.

The male of any unknown species can be identified by dissecting it under a dissecting microscope and going through the pages of drawings of genitalia at the end of Evans's book. When genitalia are very similar in allied species, the key will generally show differences in the imago. In very few cases is the amateur left in doubt. Brigadier Evans does all his dissections by moistening the end of the abdomen with wood naptha. The body is held in the fingers or by a forceps with a clip and the skin removed by a needle and forceps. The left clasp is detached and stuck, inner side upwards, on a card by an adhesive, such as seccotine. The rest of the genitalia are detached all together and stuck on the card which is placed below the insect on the pin. Much practice is needed as at first one breaks off portions. If the novice has only one or two specimens of a species and fears failure he can cut off the tip of the abdomen and soak overnight in, or boil for two minutes in a test tube in, a ten per cent solution of potassium hydroxide, wash and dissect in methylated spirit in a watch glass. The left clasp is detached and put alongside the rest of the genitalia on a card when the spirit will at once soak away into the card and the genitalia can be moved into a spot of adhesive on the card. This latter method is not a good scientific one as curling may ensue on the card and small differences in clasps of nearly allied species may become unrecognisable by distortion, but it allows the amateur to identify species by an easy dissection. By both methods the laborious art of slide making is avoided. If at the time of capture the genitalia are extruded by pinching the abdomen, they can be seen subsequently at any time without dissection. Also dissection is not necessary if the genus is known or can be guessed by a collector with some experience. He will then know what to look for and can merely brush away the scales by a small brush with its hairs cut very short and expose a clasp. If a view of the inner side of the clasp or of the ventral aspect of the uncus is required the end of the abdomen can be moistened with wood naptha and a needle used to open the clasps. For such inspection removal of the abdomen from the thorax may not be necessary.

Females are often a difficulty and sometimes an impossibility unless the corresponding male has a distinctive locality and I have to thank Brigadier Evans for his never failing help in such cases.

Bibasis oedipodea, *jaina*, *harisa*, *vasutana* NR, *amara*, *gomata sena.*
Hasora anura, *chromus*, *taminatus*, *badra.*
Badamia exclamationis.
Choaspes plateni, *benjaminii*, *xanthopogon*, *hemixanthus.*
Capila phanaeus, *pennicillatum*, *pieridoides*, *jayadeva.*
Lobocla liliana.
Celaenorrhinus pyrrha, *ratna*, *plagifera*, *platula*, *leucocera* (the commonest), *putra*, *munda*, *nigricans*, *badia*, *asmara*, *zea*, *dhanada aurivittata.*
Darpa hanria.
Coladenia dan festa, *dan fatua* NR, *fabia* NR, *indrani*, *agni.*

Sarangesa dasahara VC.
Satarupa gopala.
Seseria sambara.
Chamunda chamunda.
Daimio sinica C., *phisara* C.
Tagiades japetus NR, *gana*, *parra*, *litigiosa* C, *menaka* NR, *cohaerens.*
Mooreana trichoneura.
Ctenoptilum vasava.
Odontoptilum angulata.
Caprona agama.
Spialia galba.
Asticopterus jama C.
Arnetta atkinsoni.
Ochus subvittatus.
Barachus vittatus.
Aëromachus stigmata, *jhora.*
Sebastonyma dolopia.
Sovia grahami, one in B.M., *lucasii magna*, one in my coll.
Thoressa cerata, *fusca debilis*, only the type male and female.
Halpe zema, *kumara*, *knyvetti*, *sikkima*, *porus*, *homolea* NR, *arcuata*, *wantona.*
Pithauria stramineipennis NR, *murdava* NR.
Iambrix salsala VC.
Koruthaialos rubecula, *butleri.*
Stimula swinhoei.
Ancistroides nigrita.
Notocrypta paralysos NR, *curvifascia* C, *feisthelhami* NR.
Udaspes folus.
Scobura phiditia, *isota.*
Suastus gremius, *minuta.*
Copitha purreea.
Zographetus satwa.
Hyarotis microstictum.
Plastingia callineura, one in B.M., one in my coll., *naga*, one in B.M.
Lotongus sarala.
Gangara thyrsis.
Zela zeus, only the type.
Erionota torus, *thrax*, *acroleucus.*
Matapa aria, *druna*, *savisarna*, *cresta*, *purpurascens.*
Ochlodes subhyalina, *siva*, *brahma.*
Oriens gola C, *goloides* C.
Potanthus rectifasciata, one in B.M., *trachala*, *pallida*, one in B.M., *pseudomaesa*, *juno*, one in B.M., *sita*, one in B.M., *confucius*, *lydia*, *ganda*, one in B.M., *nesta*, one in B.M., *palnia.* On dissection the species found is usually *palnia.*
Telicota colon, *linna*, *ohara.* (*ancilla* may occur but dissections hitherto have shown only *linna*).
Cephrenes chrysozoa.
Parnara guttatus C, *ganga*, *naso.*
Borbo bevani C.
Pelopidas sinensis, *agna*, *assamensis* NR, *conjuncta.*

Polytremis lubricans C, *discreta* NR, *eltola* NR.
Baoris farri, *penicillata*.
Caltoris sirius, one in B.M., *cahira*, *bromus*, *cormasa*, *kumara*, *tulsi*.

June 14, 1956.

SIR KEITH CANTLIE,
I.C.S. (Retd.)

32. FURTHER NOTES AND ADDITIONS TO THE LIST OF BUTTERFLIES FROM BOMBAY AND SALSETTE

With reference to the list of butterflies from the above areas, published in Vol. 50, No. 2 of your journal, and the further list in Vol. 53 of December 1955, I have recently spent a further five months in Bombay from early February to the end of June 1956. During this time I was able to spend most week-ends collecting, and have to record the following additions to the list:

1. **Pantoporia perius**. This is fairly common along the stream which runs from Tulsi Lake through the Kanheri National Park, and also at Powai Lake.

2. **Neptis jumbah.** A single male was taken near Tulsi Lake and another on the path between Tulsi and Vihar Lakes. This is a rare insect on the Island.

3. **Amblypodia centaurus.** Two males and one female were taken on the stream between Tulsi Lake and Kanheri, and another male on the stream between Tulsi Lake and Powai Lake.

4. **Pratapa deva.** Two males taken on the hilltop to the north-east of Powai Lake, and several others were seen in the same place.

5. **Rapala schistacea.** Several males on a hilltop where the Ghodbunder Road attains its highest point between Ghodbunder and Thana.

6. **Gangara thyrsis.** A male flew into my flat at 9 p.m. at Hill Park, Malabar Hill, and settled on a lamp, where it was taken by hand. Others were seen in the late evenings in the garden.

During the hot weather the stream running from Tulsi Lake through Kanheri National Park is practically dry, but there are several parts where butterflies are to be found, and at the lake end there is always a trickle of water. This is one of the best areas on the Island.

This year was a good one for *Kallima Phillarctus Horsfieldii* and there was not a single day without seeing at least three or four. One was even seen in the City immediately outside the Society's Office, and another in the garden of Hill Park, Malabar Hill.

Another butterfly much commoner than usual was *Graphium nomius nomius* of which there were literally hundreds at wet patches on the stream mentioned above at the end of May.

Other butterflies seen this year, of which I had previously only taken a single specimen, were:

Appias albina.
Euploea crassa

Apatura camiba
Euthalia lubentina
Rapala melampus
Syntarucus plinius
Spindasis lohita
Sarangesa dasahara

P. O. Box 150,
Rangoon, Burma,
August 25, 1956.

A. E. G. BEST

33. ON THE PHENOMENON OF DRUMMING IN EGG-LAYING FEMALE BUTTERFLIES

Dr. Ilse's note about the 'Behaviour of Butterflies before Oviposition' [*JBNHS*, 1956, 53 (3)] very lucidly reviews the present state of our knowledge of the 'drumming' behaviour—quick alternate tapping on the leaves with forelegs--by female butterflies immediately before the deposition of each egg. The reference made by her to my observation on the behaviour of the egg-laying female of the Lemon Butterfly, *Papilio demoleus*, encourages me to write the following few lines on this subject.

While working on the colour and form perception in some butterflies, I had occasion of observing their way of life very closely. To study the normal behaviour of these butterflies, natural surroundings were imitated as nearly as possible in a special part of a large cage. Here, I was able to observe 'drumming' in *Papilio demoleus*, *Papilio polytes*, *Polydorus aristolochia* and *Graphium agamemnon*. I actually used this behaviour in the female of *Papilio demoleus* as a basis for a series of experiments on colour vision (Vaidya, 1956).

There is still a lot of doubt about the exact purpose served by such tapping on the leaf by female butterflies before oviposition. The explanation offered by Bell (1909)—that it helps in driving away the spiders and micro-ichneumons from the leaf which would otherwise destroy the eggs and the larva--seems to me also too fragile to be acceptable. Dr. Ilse (l.c.) maintains that this behaviour allows the female butterfly to select the exact plant (larval host plant) for egg-laying by testing the chemical properties of the leaf, and then to select such a leaf as is not too turgid or too dry by testing its physical properties. This explanation, which comes of a long standing experience of nature study, seems to be very near the truth.

Some of my recent observations, however, stand in apparent contradiction to the above hypothesis. They are as follows:

(*a*) During my experiments on the responses to colours by the egg-laying females of the Lemon Butterfly, *Papilio demoleus*, I observed that an egg was laid on an artificial paper leaf (a saturated blue-green paper of the standardized Ostwald series). In view of the fact that this paper was not even remotely identical with a leaf of the citrus (the larval host plant) in physical properties like texture, turgidity, etc., nor in its chemical nature, it is difficult to explain this behaviour by Dr. Ilse's hypothesis. It seemed that the actual response to coloured papers by the egg-laying females was directed by the odour of the citrus plant kept outside the cage but not very far away from the experimental arrangement.

(*b*) In the presence of a strong odour of crushed citrus leaves a number of females of *Papilio demoleus* in my cage actually laid *after drumming*, a large number of eggs on wet soil, on white mosquito-netting, on wire-netting, on an empty tin (which I sometimes used to store water), on my white dress and even on my fingers. This observation shows that even where drumming is performed, eggs may be laid, under certain conditions, on objects in no way comparable to a citrus leaf.

(*c*) Recently, I was watching in the Citrus Nursery attached to the Government Fruit Experimental Station at Kirkee, a female of *Papilio demoleus* laying eggs. On two occasions, I found that *after performing the usual drumming* this female laid eggs on two different weedy plants growing in the citrus beds. One of them belonged to the Compositae and the other to the Graminae. These are surely quite unlike in chemical composition to Rutaceae, to which all citrus plants belong. Moreover, it must be remembered that the plants belonging to Compositae and Graminae can never support the larval development of *Papilio demoleus.*

In the light of these observations, I feel, it is necessary to reconsider the whole problem of 'drumming behaviour' in egg-laying butterflies.

In *Papilio demoleus*, I have observed that the drumming is accompanied by the simultaneous fluttering of the wings. At the moment of the actual deposition of an egg, the drumming stops abruptly but the fluttering of wings continues. It seems that drumming and fluttering of wings are effects of some common cause.

As an egg rapidly makes its way through the oviduct to the female genital opening as a result of contraction of muscles in the wall of the oviduct, the female is probably under the influence of 'pangs of labour' of considerable intensity. May I suggest that drumming with forelegs and fluttering of wings are probably nothing but external manifestations of a momentary uneasiness arising from pain?

A detailed discussion on this subject will be included in a paper on the observations and experiments on the behaviour of the egg-laying female of *Papilio demoleus.*

DEPARTMENT OF ZOOLOGY,
UNIVERSITY OF POONA,
POONA-7,
August 22, 1956.

VIDYADHAR G. VAIDYA

LITERATURE

Bell, T. R. (1909): Common Butterflies of the Plains of India, *JBNHS*, **19** (3).

Ilse, Dora (1956): Behaviour of Butterflies before Oviposition, *JBNHS*, **59** (3).

Vaidya, V. G. (1956): Observations and Experiments on the Behaviour of the egg-laying Female of *Papilio demoleus* L., (Unpublished).

34. THE POISONOUS QUALITIES OF *CALOTROPIS GIGANTEA* R. BR.

Recently I came across the following reference on the subject in the *J. Ceylon Br. Asiat. Soc.* 4: 157-159, 1865-1866: 'A few remarks on the poisonous properties of the *Calotropis Gigantea,* the Mudar of Bengal, the Yercum of the Tamils, and the Warra of the Sinhalese', by W. C. Ondaatje, Esq. Asst. Col.-Surgeon.

The author of the paper writes: 'From the effects which the milk of *Calotropis gigantea* has thus been ascertained to produce, it appears to me to belong to the class of Narcotic-Irritant poisons . . .' And further down: 'The milk of the Mudar may be placed on the list of the most deadly vegetable poisons in Ceylon and India . . .'

It is generally accepted that the sap of *Calotropis gigantea* and other species of the same genus is poisonous; but the following observations may show the contrary. Whilst engaged in the botanical survey of Saurashtra, on many occasions I did notice that shrubs of *C. procera* and *C. gigantea* seemed to be much damaged as if browsed upon by some animals—cattle and goats? But I did not see any of these animals eating the plants. Both species are common in Saurashtra, and during the dry season one often sees bushes of *Calotropis* with nothing but the bare stems.

In October last year I did in fact see goats actually eating *Calotropis gigantea* leaves. I had climbed to the top of the ghat road at Khandala, when I met a large flock of goats being driven towards Bombay. The goats were marching along and stopping occasionally for a bite on herbs or shrubs near the road. Several goats stopped near a shrub of *C. gigantea* and proceeded to eat its leaves with apparent relish and plenty of haste; when they had finished every leaf on the shrub, they continued their march along the road. Their lips, nostrils and in fact most of their heads were covered with the white milky sap of the plant. It was further noticed that although there was plenty of grass on the ground, goats did not pay any attention to, it, and went straight for *Calotropis.*

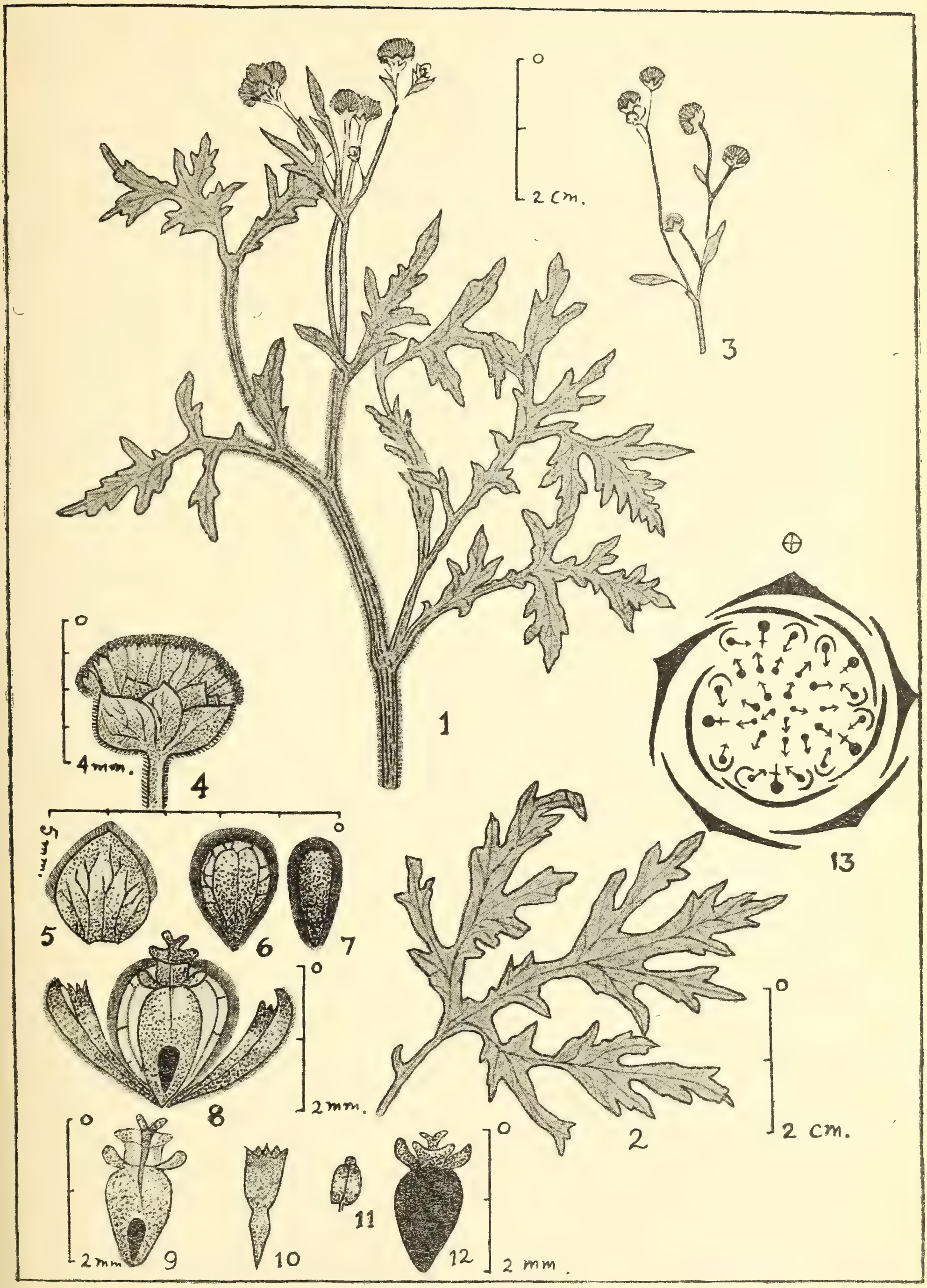
From this observation, two points seem to be clear: the first is that the plant is not such a violent poison as the quotation given above would suggest; the second is that goats, and possibly other ruminants, may develop a particular taste for some plant that in itself may be rather unpalatable.

St. Xavier's College,
Bombay, H. SANTAPAU, S.J.
August 27, 1956.

35. *PARTHENIUM HYSTEROPHORUS* LINN., A NEW RECORD FOR INDIA

(*With a plate*)

During my stay at Poona in January 1956, Shri H. Paranjape, Retired Horticulturist, Government of Bombay, gave me a specimen for identification, saying that he had found it growing as a stray


1
2
3
4
5
6
7
8
9
10
11
12
13
0
2 cm.
0
4mm.
5mm.
0
0
2mm.
0
2 cm.
0
2mm
0
2 mm

Parthenium hysterophorus Linn.

Fig. 1. Twig. 2. Leaf. 3. Apical part with inflorescence. 4. Inflorescence. 5. Outer bract. 6. Bract of female flower. 7. Bract of male flower. 8. Female flower with bract and with a pair of male flowers with bracts. 9. Female flower. 10. Male flower. 11. Stamen. 12. Fresh fruit. 13. Diagrammatic representation of floral arrangement in inflorescence.

plant in his compound. The same species was later found to be growing in abundance as a weed near the river bank and in a scattered state along the dry fields surrounding Poona Agricultural College. The plant has been identified as *Parthenium hysterophorus* Linn. There seems to be no record of this plant from India or even from Bombay State in particular. As it may be of interest for other botanists, a detailed description (prepared by the writer as no description could be procured from the literature available with him) together with the diagrams of various parts of the plant, is given along with this note.

Plant: herbaceous growing to a height of about 1-1.2 metres (3.5-4 ft.), the diameter of upper part upto 45-60 cm. (1.5-2 ft.), *Stem*: whitish hairy, angular, longitudinally grooved, profusely branched. *Leaves*: alternate, simple but pinnately and irregularly much dissected, dissected tips acute, margin entire, pubescent on both sides but more so on upper surface, hairs whitish, thin texture, venation more prominent on lower surface, length varying from 2-8 cm. breadth upto 5 cm. *Inflorescence*: terminal or axillary, peduncled, peduncle upto 1 cm., slightly hairy, head with an involucre of usually 5 outer bracts followed by 5 very thin bracts each subtending a female flower with two male flowers one on either side, each male flower in turn enclosed in a bract of its own and then finally followed by male flowers only, probably without bracts or bracts insignificant or represented by hairy structures, all bracts and floral arrangement spiral (vide fig. 13), head upto 4 mm. long, 4-5 mm. in diameter, outer bracts ovate, acute, upper two-thirds of margin lined by fine hairs, venation prominent, upto 2.5 mm. long, upto 1.5 mm. broad. *Female flowers* usually five, bracteate, bract obovate, thin, transparent, margin lined by irregular filmy layers, venation distinct, upto 2 mm. long or slightly more, upto 1 mm. broad or slightly more, flower jug-shaped with ovary as distinct lower part, corolla as cup-shaped upper part, lobes indistinct, enclosing style, stigma bifurcated, slightly exerted, stylar canal faintly visible through transparent ovary, two appendages one on either side at the junction of the upper and lower parts, ovule single, basal, dark, distinct, flower upto 2.5 mm. long. *Male flowers* developed in pairs along with five female flowers and after that developed singly; flowers developing with female flowers bracteate, bracts oblanceolate, thin, transparent, margin lined by irregular filmy layers, somewhat boat-shaped in young stage enclosing male flowers, upto 2 mm. long or slightly more, upto 0.5 mm. broad or slightly more, male flower in general more or less infundibuliform with a slight constriction demarcating lower abortive ovary and upper transparent corolla, lobes five, distinct, acute, stamens five, syngenecious, anthers with small knob-like prolonged connective, filament very short, flower upto 1.5 mm. long or slightly more. *Fruit*: in fresh stage ellipsoid, obovate, dark, brittle with remnants of cup-shaped corolla, appendages and style persistent, 2 mm. long, 1 mm. broad.

The plant is said to be a native of the West Indies, Central and Northern America. Collections from West Indies, United States of America and South Africa only are available in the Herbarium of the Indian Botanic Garden, Calcutta. There are however, no collections from India in that Herbarium. This is possibly an exotic weed and has probably got acclimatised in the Western part of India. Further exploration in the various parts of India, particularly Western India, may reveal its occurrence in other localities. It would be interesting to gather details of its economic importance if any.

Botanical Survey of India,
Eastern Circle,
Nirala,
Shillong,
August 3, 1956.

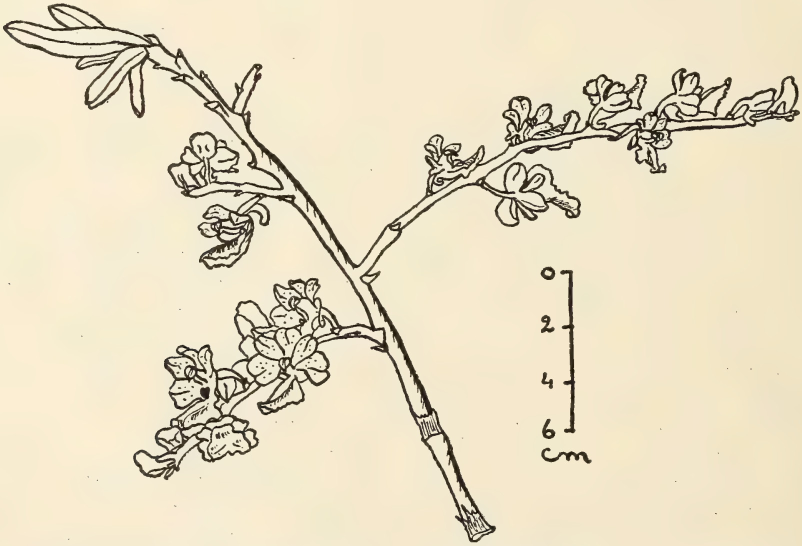
R. SESHAGIRI RAO
Regional Botanist

36. NOTES ON *AERIDES MACULOSUM* LINDL.

(*With a text figure*)

This is one of the most beautiful of our Bombay orchids; and until a few years ago, it was one of the most common of the wild orchids indigenous in the State; its beauty has been its undoing, for many visitors to our hill stations plundered the countryside and removed whatever specimen was easily available.

Recently we found a specimen in the cemetery of Purandhar Fort, Poona District, that was noteworthy for its very large size; total length 28 cm., leaves 8 pairs, each up to 32 × 5 cm. This plant has been under cultivation in Bombay, and has come into flower in April of this year.



Aerides maculosum Lindl. showing flowers and vegetative proliferation

Many orchids seem to have a rest period during which flowers are not produced; this apparent inability to flower has caused many collectors to throw away otherwise valuable specimens. We have kept our plant under observation since October 1954; for the period

October 1954 to June 1955, the plant was watered regularly every day, but it did not flower; after the monsoon rains of of 1955, the plant was left unwatered until this year's monsoon supervened. During the period when the plant was regularly watered, its vegetative growth was fast; during the dry season, when it was left unwatered, growth was slow, but this seems to have induced profuse flowering. At the end of April of this year we noticed the first signs of the coming flowers; by the middle of May 1956 it showed a large bunch of flowers (a central rachis with four lateral branches).

Towards the end of May of this year the flowering spike gave rise to a vegetative proliferation at its end; gradually 4-6 fleshy leaves, much smaller in size than those at the base of the plant, appeared beyond the flowers; these terminal leaves gradually fell off, but new leaves appeared in their place, so that 4-6 were always present on the plant.

Unfortunately we had only one specimen, and so could not carry out experiments with proper controls, on the effect of the profuse watering during the dry season. It is quite possible that the early flowering of the plant and its vegetative proliferation may be due to the abnormal watering it received. The plant in its wild state is known to flower only between the end of May and the middle of June.

The diagram herewith appended was drawn by one of us from the living specimen. At present the preserved plant is kept in Blatter Herbarium of our College.

H. SANTAPAU, S.J.
Z. KAPADIA, B.SC. (Hons.)

ST. XAVIER'S COLLEGE,
BOMBAY,
July 5, 1956.

37. SOME NEW PLANTS FOR THE DANGS FOREST, BOMBAY STATE

(*With two plates*)

Under the auspices of the Gujerat Research Society, the senior author has been conducting intensive botanical surveys in the Dangs Forest; some of his research students have joined in many of his outings. The results of the survey of the Dangs Forest have been published in the *Jour. of the Gujerat Res. Society;* the work is still continuing. The present paper gives details of two striking plants that have been found to be rather common all over the Dangs. The junior author has been working on the Papilionaceae of Bombay State and has accompanied the senior author on several excursions to the Dangs.

Indigofera oreophila spec. nov.

Accedit ad *Indigoferam tritam* Linn. charactere generali florum, foliorum et habitus; ab ea tamen differt praesertim sequentibus notis :

foliorum magnitudine et forma, inflorescentia aeque longa ac folia vel hisce duplo longiore, fructibus tenuioribus.

Suffrutex valde ramosus, 150-180 cm. altus; *culmi* teretes et sublignosi ad maturitatem, tenues et paulo angulati in juvenili conditione, adpresse albo-pilosi. *Folia* trifoliata, alterna, petiolata, stipulata; petiolus 20-27 mm. longus, productus 10-13 mm. ultra foliola lateralia, adpresse pubescens, supra late et tenuiter canaliculatus. *Foliola* 3, membranacea, 22-45 × 12-15 mm., elliptico-oblonga, rotundato-apiculata ad apicem, obtusa ad basim, integra, paulo adpresse pubescentia in superiore pagina, in inferiore vero plus pubescentia et pallide viridia; nervi laterales 4-5-jugi, alterni, indistincti; petioluli 1-2 mm. longi, aliquantum tumescentes, pubescentes; stipulae 3 mm. longae, subulatae, ciliatae, persistentes; stipellae minutae, lineares, persistentes. *Inflorescentia* axillaris, racemosa; inflorescentiae rachis 5-20 cm. longa, angulosa, pubescens, tenuissima, saepe ad apicem curvata, fructifera evadens aliquanto robustior. *Flores* 20-40, laxe dispositi, pedicellati, bracteati, pediculo 1 mm. longo, erecto sub alabastro, reflexo sub flore et fructu, bracteis singulis sub unoquoque pediculo, 2-2.5 mm. longis, subulatis, pubescentibus, caducis. *Calyx* 3-4 mm. longus, fere ad basim usque divisus, dense et adpresse pubescens, sub fructibus persistens; dentes 5, inter se aequales, lineari-lanceolati, ciliati. *Corolla* rubra, exserta; vexillum 5 × 4 mm., suborbiculare, sessile, fastigatum ad basim, tenuiter pubescens in parte dorsali; alae 5 × 1.5 mm.; carina 5 × 1 mm., calcarata ad basim, ungue 2 mm. longo ornata. *Stamina* 9+1; filamenta 5 mm. longa, sub apice libera per 1 mm., alterna quidem breviora; antherae uniformes, basifixae, apiculatae. *Ovarium* 3 mm. longum, lineare, tenuissime pubescens; stylus 1 mm. longus, angulum rectum cum ovario efformans; stigma capitatum, terminale. *Legumen* 25-30 × 1 mm., tetragonum, lineare, apiculatum, adpresse pilosum, reflexum, intus septatum. *Semina* 7-8, singula 2 × 1 mm., ovoidea, levia, ochracea colore.

Typus lectus in Dangs Forest, in loco Waghai, die 23 mensis octobris, anni 1955 a D. P. Panthaki, et repositus in Blatter Herbario, Bombay, sub numero 2,350; paratypi *Santapau* 19,985, 20,081 et 20,281 lecti eodem in loco et positi in Blatter Herbario et in herbario Hortus Regii Kewensis, in Anglia, paratypus alius, *Panthaki* 2,415, positus in Blatter Herbario.

Indigofera oreophila spec. nov.

This new species approaches in many respects *Indigofera trita* Linn.; the general character of the plants is the same, the shape and structure of flowers is rather closely similar. The main differences are the following: the leaves are much large, the leaflets broader, the inflorescence much longer, at times even twice as long as the leaves, the fruits somewhat more slender in the new species.

Undershrub, much branched, 150-180 cm. tall. *Stem* terete and subwoody when old, slender and slightly angled when young, appressedly white-pubescent. Leaves trifoliate, alternate, petiolate, stipulate; petiole 20-27 mm. long, produced 10-13 mm. beyond the attachment of the lateral leaflets, appressedly pubescent, with a broad shallow groove. *Leaflets* 3, membranous, 22-45 × 12-15 mm., elliptic

—oblong, apex rounded-apiculate, entire, base obtuse, upper side appressedly slightly pubescent, the lower one more so and pale green; lateral nerves 4-5 pairs, alternate, rather faint; petiolules 1-2 mm. long, slightly tumid, pubescent; stipules 3 mm. long, subulate, ciliate, persistent; stipels minute, linear, persistent. *Inflorescence* axillary, racemose; rachis 5-20 cm. long, angled, pubescent, very slender, often curved at the apex, becoming somewhat stouter in fruit. *Flowers* 20-40, laxly arranged, pedicellate, bracteate; pedicels 1 mm. long, straight in bud, reflexed in flower and fruit; bracts one at the base of each pedicel, 2-2.5 mm. long, subulate, pubescent, caducous. *Calyx* 3-4 mm. long, divided nearly to the base, strongly and appressedly hairy, persistent in fruit; teeth 5, equal, linear-lanceolate, ciliate. *Corolla* red, exserted; standard 5 × 4 mm., suborbicular, sessile, tapering at the base, downy on the dorsal side; wings 5 × 1.5 mm.; keel 5 × 1 mm., connate dorsally except for the claw, bearing a short spur before tapering into a 2 mm. long claw. *Stamens* 9+1; filaments 5 mm. long, free for less than 1 mm. from the apex, every alternate one slightly shorter; anthers uniform, basifixed, apiculate. *Ovary* 3 mm. long, linear, puberulous; style 1 mm. long, bent at right angles to the ovary; stigma capitate, terminal. *Fruits* 25-30 × 1 mm., tetragonous, linear, apiculate, appressedly hairy, reflexed, septate within. *Seeds* 7-8, each 2 × 1 mm., ovoid, smooth, yellow ochre.

The type of this new species has been collected at Waghai, in the Dangs Forest, on the 23rd October, 1955 by Miss D. P. Panthaki, and has been deposited in the Blatter Herbarium, Bombay, under the number *Panthaki* 2,350; the paratypes, *Santapau* 19,985, 20,081 and 20,281, collected from the same locality, have been placed in Blatter Herbarium and in the Herbarium of the Royal Botanic Gardens, Kew, in England; another paratype, *Panthaki* 2,415, has also been deposited in Blatter Herbarium.

This new species is quite a striking plant. It grows gregariously in dense clumps usually in the undergrowth of tall forest, the clumps at times being over 5 m. in diameter; the usual or average height of the clumps is well over one metre, and some individual plants reach nearly to 2 metres. Another noteworthy feature of the plant is the size of the inflorescence, which often is at least twice as long as the full-grown leaves. In general appearance the plant is decidedly a shrub or undershrub, as against *Indigofera trita* L., which is only a more or less robust herb.

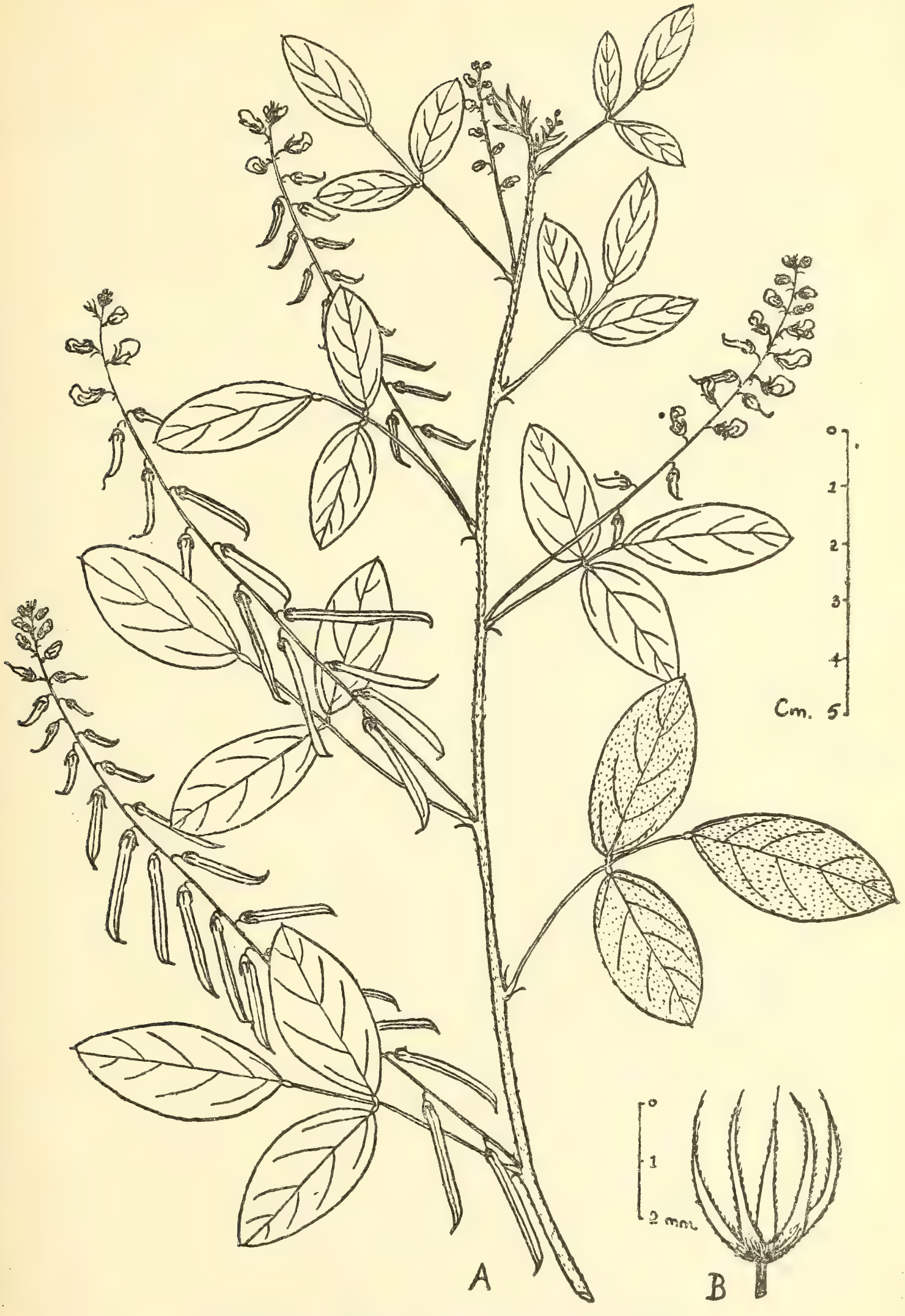
Our new species has been found in flower in October-November, in fruit from November to January. Examination of the species of *Indigofera* from Bombay State, in Blatter Herbarium, has revealed that our new species is fairly widely distributed in Bombay State; we have seen specimens from various parts of the Dangs Forest, from Purandhar Hill, Poona Dt., and from Borivli; in every case the plant grows in the undergrowth of the forest, or where no forest is present, in the undergrowth of tall shrubs. We have named it *oreophila* to commemorate the fact that the new species seems to be restricted to the hills in Bombay State; we have seen no specimen from the low parts of the Konkan proper.

The main differences between our new species and *Indigofera trita* Linn. can be given in tabular form as follows:

	Ind. trita L.	*Ind. oreophila.*
Stems ...	60-120 cm. high	150-180 cm. high.
Leaves ...	8-22 × 5-13 mm.	22-45 × 12-15 mm.
Leaflets ...	Obovate-oblong or sub-orbicular.	Elliptic-oblong.
	Petiole 4-13 mm. prolongued 1-6 mm.	Petiole 20-27 mm. prolongued 10-13 mm.
	Petiolule less than 1 mm. long.	Petiolule 1-2 mm.
Racemes ...	0·6-4 cm. long.	5-20 cm. long.
	Flowers close.	Flowers lax.
	6-12	20-40.
Fruit ...	Woody, 2 mm. thick.	Slender, 1 mm. thick.

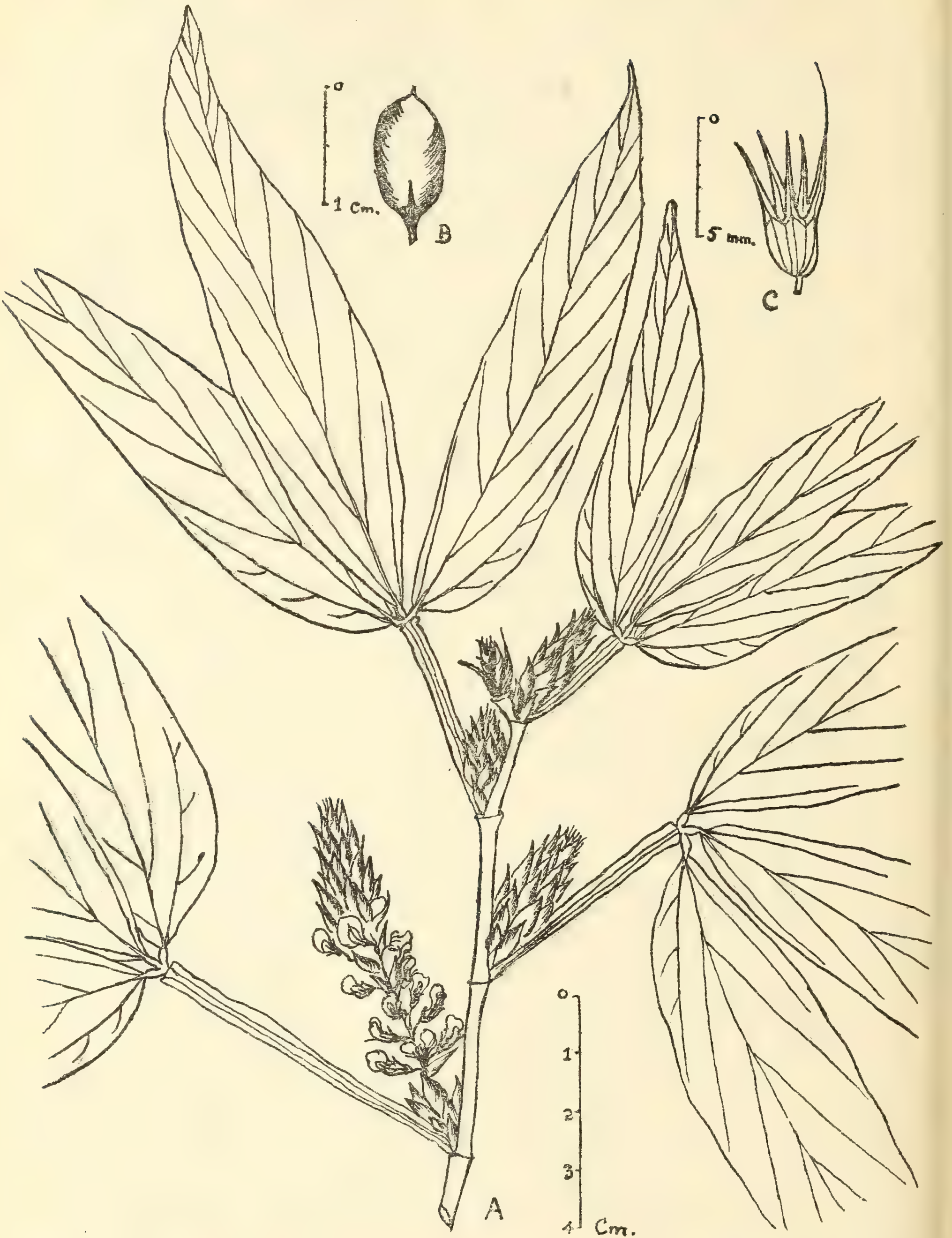
Moghania praecox H.L.Li., var. **robusta** Mukerjee in Bull. Bot. Soc. Bengal 6: 19, 1953.

An erect undershrub, 120-210 cm. high, much branched; *stem* woody, terete, younger parts somewhat triquetrous, faintly striate, glabrous. *Leaves* trifoliate, alternate, petiolate, stipulate; leaflets 11-25 × 2-6.8 cm., subcoriaceous, oblong-ovate, or lanceolate, obscurely repand, acuminate, base of central leaflet cuneate, that of lateral ones oblique and rounded, upper surface glabrous, lower one dotted with minute golden brown glands, and puberulous especially about the veins; nerves three strong ones from the base with in addition 6 or 7 pairs higher up; petioles 4.5-8.5 cm. long, slightly winged, smooth on the dorsal side, deeply fluted on the upper or ventral side, puberulous, the base expanded into a slight pulvinus; stipules 10-13 mm. long, scarious, ovate, acuminate, ciliate, striate, conduplicate, caducous; stipels absent. *Inflorescence* axillary, racemose; rachis 2.5-8 cm. long, angled, glabrous. *Flowers* 30-50 in each raceme, close, each supported by a bract and pedicellate; bracts 6-8 × 2-4 mm., the basal ones ovate to broadly-ovate, the higher ones elliptic, all striate, ciliate, caducous; pedicels 1-2 mm. long, slender, glabrous. *Calyx* 6-9 mm. long glabrous, persistent in fruit; tube 2 mm. long, campanulate; teeth 5, free, ovate- acuminate 4 mm. long, the lower ones the longer, nearly 7 mm. long. *Corolla* dark purple, exserted; standard 8 × 6 mm., greenish with dark purple veins, suborbicular, acute, with two short spurs before tapering into a claw, which is 2 mm. long, wings 6 × 1 mm., white or green with a few purple veins, each with a spur just above the 2 mm. long claw; keel 8 × 3 mm., almost purple black at the tip, the colour gradually becoming lighter towards the base, connate on the dorsal side up to the claw, which is 2 mm. long. *Stamens* 9 + 1, filaments 8 mm. long, united together except for about 1 mm. near the apex; anthers uniform, minute. *Ovary* 2 × 1 mm., straight on the dorsal side, rounded on the ventral, glabrous; style 7 mm. long, slender, inflexed; stigma hairy. *Fruit* 10 × 6 mm., turgid, oblong, slightly apiculate, glabrous, brown. *Seeds* 2, black, smooth, truncate, each 2 × 2 mm.


0
1
2
3
4
Cm. 5
0
1
2 mm
A
B

Indigofera oreophila Santapau and Panthaki

A. Upper branch in flower and fruit; B. Calyx in fruit.


0
1 Cm.
B
0
5 mm.
C
A
0
1
2
3
4 Cm.

Moghania praecox var. *robusta* Mukerjee

A. Flowering branch; B. Fruit; C. Flowering calyx

This plant is very noticeable on account of its size and its gregarious habit; it grows in dense clumps at the edges of forest; it is also found in the undergrowth of some of our more dense forests. It comes into flower in January-March, and into fruit in March. The records of this species which we have been able to examine are the following:

T. R. D. Bell 3634/II, from North Konkan, February 1918.

Santapau 19227, from Waghai, in the Dangs Forest, September 1954.

N. A. Irani 1688-1689, from Waghai, February 1956.

D. P. Panthaki 2571-2573, Waghai, February 11, 1956; *Panthaki* 2591 from Waghai, 12 February 1956.

Distribution: *Moghania praecox* proper has been recorded only from Chittagong in East Pakistan (*C. B. Clarke* 19916 A, B, C); the present variety has been recorded from Yenkatapur, in Chanda Dt. of C.P., Thana and Dangs Forests in Bombay.

H. SANTAPAU,
S.J., F.N.I.,
D. P. PANTHAKI,
B.SC. (Hons.)

38. CHINA'S BOOK-LIKE ROCK FORMATION WITH 25-MILLION YEAR OLD PLANT FOSSILS

Numerous plant fossils of the Upper Miocene Age some 25-million years old can still be seen today near Shanwang Village in the Linchu district of northern Shantung Province. They are imbedded in a peculiar rock formation locally called the 'Ten Thousand Volumes'.

The district in which Shanwang Village is located lies twenty kilometres south of the Tanchiafang station on the Tsingtao-Tsinan Railway which cuts across the peninsula. At a place called Hsiehchiachuang, in a valley which faces the northeast, outcrops of volcanic sediments one and a half kilometres long are covered with basalt of the Pliocene epoch. In the shale rockbeds are found large quantities of volcanic ash intermingled with which are numerous thin layers of diatomaceus earth. With only the help of a pen-knife, these thin layers can be easily pried loose. And there, lying among these layers, are leaves, flowers and fruits of ancient plants. The peasants here call them 'Ten-thousand-volume' rockbeds because these thin layers of white volcanic ash resemble the pages of an enormous book. This is a very significant and descriptive name indeed.

By 'opening' this 'heavenly book' as it is otherwise called, scientists are able to know the various kinds of plants in this 25-million year old area as well as the difference between plants of that time and now. They can also find out what changes have happened during the past 25-million years and the causes that have brought about these changes.

The plants hidden in the rock beds of the 'Ten-thousand-volumes', covering a wide range of varieties, are so well preserved that they look like herbarium specimens. Even the chlorophyl is still preserved in them. Most of them are leaves, though flowers and fruits are also found among them. Two kinds of monocotylae (plants with only one seed leaf) and eighty-four kinds of dicotyledonea (plants with two seed leaves) have been determined. No gymnospermae (plants having naked seeds such as pines, cedars) have been found. The dicotyledonea consist of fifteen orders, thirty families and sixty-one genera. There are seven kinds each of genus *Acer* and genus *Carpinus,* three kinds each of genus *Filia* and genus *Ulmus,* the remainder being of only one or two species.

Most of the plant fossils belong to the flora of eastern Asia. *Eriobotrya, Firmiana, Kalopanax* and *Platycarya* are genera found only in eastern Asia. The genera of *Carya, Gladitsia, Hamamelis* and *Liquidambar* do not exist in northern China now-a-days. In general, two-thirds of these genera now grow in the valley of the Yangtze River. Thirty-nine kinds of the plant fossils are similar to present-day Japanese plants and eighty-five kinds belong to the same present-day Japanese plants of as many genera. They are also similar to Korean plants. The leaves of the plants are bigger and softer than those plants now found in North China.

Animal fossils such as those of insects, fishes, frogs, turtles and mammals have been collected and studied, and a series of papers have been published by Dr. C. C. Young and his associates. But the primary interest is focussed on the large collection of plant fossils.

On the basis of geological data, geologists judge that these rock formations were generated by the lake deposits which were accumulated during an age in which volcanic activities were very active. The leaves, flowers and fruits which frequently fell into the water were interlayered with frequent deposits of volcanic ash, which makes it possible to preserve beautifully these plant materials, the study of which enables the paleobotanists not only to identify those preserved plants, but also to understand the change of climate and floral elements of North China during these long geological times.

Much material has been collected and studied. But by further collection and research from those 'heavenly books' new discoveries will be made, and further knowledge of those remote times obtained.

INSTITUTE OF BOTANY,
ACADEMIA SINICA,
September 11, 1956.

PROF. HSEN-HSU HU

39. WILD LIFE PRESERVATION IN INDIA

DANDELI AND THE DANGS

All Indians who are interested in the protection of Nature are grateful to the Society for the sustained effort it is making to foster public interest in the preservation of the fauna and flora of our country. The Governments are more or less converted to this view and are moving gradually in the right direction. The creation of the Indian

Board for Wild Life and special legislation in some States are steps in that direction. Yet, in spite of the above legislative and organisational efforts, wild life is decreasing from day to day.

2. In 1942-'43, when I was Divisional Forest Officer, Kanara Northern Division, I selected an area of approximately 100 square miles suitable for a wild life sanctuary in that Division. The site selected has natural boundaries, rivers with deep gorges on three sides and well demarcated P.W.D. road and Forest block boundaries on the fourth side. It contained a representative stock of wild life and has several perennial springs and nullahs. By an executive action, sign-boards were put up at all road entrances and exits, prohibiting shooting within the area and the Conservator of Forests, Southern Circle, declined to issue shooting block permits for the shooting blocks included in the proposed sanctuary. Later, when I was the Conservator of Forests in charge of this Circle, I closed all shooting in this area by a notification under Indian Forest Act and submitted detailed proposals to Government to constitute this area into a National Park. For this purpose, it was necessary to remove 2 or 3 hamlets within the area affecting about 500 persons (about 100 families). For the rehabilitation of these persons, the proposals included the creation of a model village near Dandeli, cost of which would be met from selling the forest crop on the proposed site for this village. Here the displaced persons will have more land for cultivation than they had in the midst of the forest and better and safer grazing for their cattle. This arrangement would be to the all-round benefit of the displaced persons as they would be, at the rail head at Dandeli, enabled to obtain better prices for their agricultural and garden produce and also get the benefit of all modern social services like sanitation, medical aid, education and later on electricity from Jog etc., which was denied them due to their habitation in the forests. The following extract from the diary of Fr. H. Santapau, printed on page 26 of the *Journal,* Vol. 53, would appear to show that no effective action has been taken so far.

'30 May, 1954, Sunday. The animal sanctuary is just across the river; all we saw were crowds of monkeys, some domesticated buffaloes and heard jungle-fowl and an occasional woodpecker.'

From the above it should be realized how difficult it is for a State Government to give effect to any proposals when local interests are not sympathetic. This explains the progressive diminution of wild life all over India in spite of protective laws of the Governments.

3. Wild life preservation to be effective should be a Central responsibility away from pressure of local interests. For this purpose, the National Parks should be large enough to be self-supporting financially. Dandeli sanctuary is one such site.

Another good site for a National Park in Bombay State is Dangs. Dangs was formerly a confederation of 19 Bhil States. The forests were leased to the Forest Department of Bombay Province and the rest of the area was administered by the Political Department. With the merger, Dangs has been constituted into a District of Bombay State. The area of Dangs is about 700 square miles, hardly the area of a taluka, but for political considerations, it is administered as a district. The whole of Dangs should be constituted into a National

Park under the Union Government. I have served as a Forest Officer in Dangs. The Dangi is a good woodsman, but, rather a poor cultivator. If Dangs is taken over by the Central Government as a National Park, it will benefit both the Wild Life and Dangies. Wild life is almost eliminated from Dangs, but, it can be nursed back to normal for the locality. The objects of management of this park should be:

(*a*) Preservation of wild life;

(*b*) Preservation and improvement of environmental conditions;

(*c*) Consistent with (*a*) and (*b*), exploitation of forest resources for the benefit of Dangies.

(*d*) Social benefits and improvement in the housing conditions of Dangies.

To achieve this, some of the prescriptions of Forest Working Plans would need revision in view of the changed objects of management. The forest revenue resources of the area are more than ample to meet all the needs of Dangies in the matter of cheap food and social services like education, sanitation, medical aid, cottage industries based on forest produce, and full employment on game preservation and forest works. In fact the Dangies will be better off by the constitution of National Park than they are at present, when the forests are under commercial exploitation.

5, MODIBAG,
GANESHKHIND ROAD,
POONA 5,
October 26, 1955.

TOLARAM K. MIRCHANDANI

GLEANINGS

Falconry Revived in Germany

The 4,000-year old art of falconry received new impetus when a training centre for hawks and other raptorial birds was opened near Waldorf, in the district of Calw in Württemberg. The new training centre, which it is claimed has no match in Europe, will replace the Reichsfalkenhof in Brunswick which was destroyed in the war.

The sponsor of the new establishment is the 'Deutsche Falkenorden' which has its counterparts in the British Falconers' Club and in the Falconers' Association of North America. The 'Falkenorden', founded in 1923, held its last exhibition in Düsseldorf in 1937. England, France, Italy, Egypt, Japan, Yugoslavia, and Arabia were represented.

The task the new establishment has set itself is the training, theoretically and practically, of falcons, hawks, and other raptorial birds which can be used for hunting. All birds of prey, including the owl, can be trained to the basic art of falconry, which is to kill the quarry and remain upon it until the falconer picks up the bird or calls it to his fist. The Chinese Golden Eagle, it is said, can even be trained to retrieve its kill. History has it that falconry was known in China as early as 2,000 B.C. India, Arabia and Iran also look back on a very old tradition in this field. In Europe, the quarry at which hawks are flown consists of grouse, pheasants, partridges, ducks, woodcocks, snipe, heron, crows, gulls, magpies, hares and rabbits. In Asia, vultures and gazelles are captured by trained hawks.

[From the Bulletin of the Press and Information Service of the German Federal Republic, Bonn, June 28, 1956.]

Electrical Field set up by Lamprey

Some experiments are being made at McMaster University in Hamilton, Ontario, on the parasitic lamprey which has been destroying large numbers of trout and whitefish in the Great Lakes. It has been found that the lamprey can set up an electrical field around its head and, when this field is amplified, can light a flash bulb and trigger a camera shutter, thus taking a photograph of itself.

The research board say that these early observations are of great biological interest because the electrical field is limited to regions around the animal's head. At the moment it appears there is no resemblance between the phenomenon and that peculiar to the electric eel, which is not found in the fresh waters of Canada.

Method of Generation: It is not clear which organs of the lamprey generate the electrical field, but it is known that the field is closely synchronized with its breathing movements. The potentials could be produced by either nerve or muscle tissues, or a combination of both. A number of experiments to determine this are in progress, involving drugs and surgical techniques.

Properly described, the field is one of electrical potentials, recurring rhythmically, from 200 to 300 millionths of a volt at a distance of about four-fifths of an inch from the head of a normal lamprey in fresh water. These potentials occur every four-tenths of a second, and the duration of each is one twenty-thousandth of a second. They are called 'spike' potentials because of the shape they make on a recording machine, and they have been measured at a distance of several inches from the head. How far these electrical inpulses are valuable to the lamprey is still a matter of speculation. They can hardly be used as radar, as the impulses do not occur sufficiently often.

Signals by African Fish

The first case of fish which send out weak electrical signals, and apparently use these signals to gain information about their surroundings, was reported by Dr. H. W. Lissman of the Department of Zoology, Cambridge University, in 1951. The one which he first observed was an African freshwater fish, *Gymnarchus niloticus*, which is roughly one foot in length. It sends out continuous signals at a rate between 258 and 318 pulses a second. The rate is affected by the temperature of the water but not by the degree of activity shown by the fish. The greatest observed strength of the signals was about 30 millivolts.

Dr. Lissman found that the fish responded by their behaviour to changes in the electric field which they set up about them, and also to pulses similar to their own. Soon after he found that signals of the same general type but differing in detail were produced by two other species of fish. He pointed out that the production of these weak signals was of interest in relation to the origin of organs of electric discharge, notably in the electric eel, which give a high enough voltage to be of obvious value to the fish.

Later the electric eel itself was found by Dr. R. D. Keynes to produce smaller pulses which it appeared to use, like these other fish, to obtain information about its surroundings. These pulses, normally at the rate of about one a second and of some few volts (?) strength, are sent out by the eel only when it is moving. Their rate is increased sometimes to as much as 20 a second, when the eel is showing interest in any object near by. The case of the electric eel seems to prove that pulses sent out at comparatively long intervals can be of value to the fish.

—*The Times*, March 29, 1956.

(Government of India, Ministry of Natural Resources and Scientific Research, Science Newsletter No. 225, dated July 3, 1956.)

Atom v. *Death Watch Beetle*

Atomic scientists in the United Kingdom are planning to use the atom to outwit the death watch, beetle which each year causes considerable damage to the woodwork of ancient buildings. Physicists at the atomic energy research establishment at Harwell, collaborating with timber experts, have found that small doses of radio active cobalt can halt the reproductive instinct in the beetle and make its eggs infertile. The method they have developed will be used to protect historic buildings and furniture, the principal victims of this destructive.

—*The Chemical Age*, June 16, 1956.
(ibid., No. 265, dated September 14, 1956.)

Bee-eaters' Dust Bath

'One morning, as I was walking along the banks (of Mutha Canal, a short distance out of Poona) I saw, some hundred yards in front of me on the brown earth path what looked exactly like a heap of grass newly cut by a lawn mower which the gardener has emptied from the box of the machine. But the whole green heap seemed to be in movement. Warily I approached nearer until with my field-glasses I solved the mystery. What I had taken to be a heaving mound of grass proved to be a mass of emerald green bee-eaters, which were lying close together, higgledy-piggledy, enjoying a dust bath. Some were lying on their bellies, others on their sides, and all were flapping their wings with vigour. There must have been thirty or more birds together on one small patch of ground.'

[From 'Memoirs of a Camp-Follower' by Philip Gosse. Published 1934.]

EXTRACTS FROM THE REPORT OF THE DIRECTOR, ROYAL NATIONAL PARKS, KENYA, 1952

Barriers and Fences

'I am convinced that the only successful method of constructing such a barrier is not only to make it formidable, but also to make it impossible for the animals to see through or over to the other side of it. Few animals will charge or jump a fence when they do not know what lies beyond. . . . The growing hedge is undoubtedly the ideal but by some strange dint of nature suitable plants when grown in rows seem to attract the attention of various creatures that normally would not attempt to feed on this type of vegetation. The stretch of euphorbia along a portion of the Nairobi National Park, for example, was very quickly devoured and uprooted by zebra, although similar isolated plants growing in the same area survived for years unscathed. . . .'

Observations

'The lions in the Nairobi Royal National Park appear to circle an area in an anti-clockwise movement, and over a period of about a week they generally complete the circuit.'

'Several families of cheetah have been born and reared within the Park, and the number of cubs seems to be in each case five.'

'A few leopards are occasionally seen in this Park, and I like to hope that they are increasing. The unfortunate trapping and persecution of leopards in the past few years has reduced these animals to a point where they are below the number required by nature's plan. This is evident from the vast increase of baboons, pigs and suchlike, upon which the leopards normally prey.'

'The remarkable thing about wild Africa is the silence—or noise—of the night. There are moments when there is absolutely no sound whatever. Then there is a rustle in the dom palms; a lonely cricket chirps; an owl hoots; and a gentle breeze glides through. For no obvious reason there is then a sudden chorus of the most diabolical noises and every creature that has any means of screeching, snorting, blowing, scraping or croaking, joins in to ensure the greatest possible disturbance of the peace, and one wonders how the same cold moonlight ever appeared so lifeless.'

Artificial Lighting

Artificial lighting has been introduced at the famous observation point 'Treetops': 'Power is provided from an engine situated at the forest edge and by means of a diffused floodlight the whole arena can be illuminated up to much the same brightness as by the full moon. The key to the introduction of this system of artificial lighting lay in bringing the light up from darkness to full strength very slowly, as any sudden flood of light caused a minor stampede. In a very short time, however, most of the regular habitues of 'Treetops' learned to accept the light as part of the natural scene, and most animals, even including the normally timid rhino, continued to scuffle for salt or to take their fill of water in full view of the floodlight.

'The provision of artificial lighting in a National Park was a subject that exercised the minds of the Trustees, since it could clearly be argued that this was interference with the natural scene, and was not the kind of system one would expect in a wild life sanctuary. Since "Treetops", however, had been in operation for many years before the area had been proclaimed as a National Park, and since artificial lighting made it possible for so many more people to visit this famous place and see the animals clearly, it was considered to be a justifiable concession. Since the Royal visit in February, 1952, artificial lighting has been in use on all dark nights, and appears to have had no adverse effect on the habits of the animals.'

Salt-licks

'It has been the practice for many years to sprinkle common salt on the fringes of the pool beneath "Treetops", but this to my mind is not the entire requirement of the forest dwellers. On analysis it was found that the natural salt-lick contained an unusually high percentage of ferric oxide, and when any of this mineralised soil was placed at "Treetops" or nearby it was at once consumed by almost every kind of animal. This points to a conclusion that common salt by itself will not be sufficient to satisfy the animals at "Treetops" indefinitely, and as time goes on it may be necessary to recreate the attractions of the ridge by moving fairly large quantities of the natural salt-lick up into the forest.

'Natural salt-licks in various other National Parks have been analysed and the reports point to a very great variation in the essential components. This again is a subject for considerable scientific research, but from observations already made it seems perfectly clear that common salt by itself is not the main or only requirement.'

[A series of chemical reports on samples of earth obtained at salt-licks in India was published in the Society's *Journal,* Volumes 36-41. No conclusions were attempted and it may now be worth while re-examining them in the light of experience in other countries.]

EXTRACTS FROM I.U.P.N. BULLETINS. SELECTED AND ANNOTATED BY R. W. BURTON

The Use of Predators

In the Bulletin is mention of an excellent little brochure, 'Predator Control—Why and How' prepared by the Conservation Commission of the State of Missouri (U.S.A.) contents of which are well worth study by all concerned in the Conservation of Wild Life.

> ' . . . The important factor to be borne in mind is that the animal, predator though it may be, nevertheless has a definite rôle to play in the chain of natural balance and that every living creature is subject to the implacable law that demands the assimilation of another form of life to assure its own survival.'

Anti Parasites

In its latest Annual Report 'Nature Conservancy' (Great Britain) refers to the conclusions of an inquiry made under its auspices on spraying selective weedkillers on the vegetation of roadside verges and on hedges. Such spraying does not always have the desired effect. Some interesting species of flora have been destroyed, while others, for whom the treatments were intended, survived. . . . The Ministry of Transport has issued advice to highway authorities in a Circular (No. 718) which is to serve as a guide when selective weedkillers are being sprayed on roadside vegetation.

Forests of Yesterday

In the British Nature Conservancy's Annual Report it is shown that:

'over-grazing and over-burning have not only vastly reduced the area of Scottish woodlands but have also radically changed their composition.'

April 1956.

Hydroelectricity

'The columns of this whole Bulletin (May 1956) would not suffice to reproduce all the requests that come to the Union appealing for the preservation of areas threatened by hydroelectric schemes.' . . . 'Of course the economic needs of the country must be satisfied, but other sites that are less precious to both naturalists and to scientific study could surely be used, even although they may be further from the development sites.'

Education

India: 'The Governor of West Bengal has stressed the need for education to impress on the Indian people the great national heritage which their wild life gives them.

In his opinion, wild life on account of its beauty and rarity, is well worthy of government protection.'

May 1956.

NOTES AND NEWS

The Council of Biological and Medical Abstracts Ltd., London, has decided to change the title of their journal *British Abstracts of Medical Sciences* to

International Abstracts of Biological Sciences

(Honorary Editor: C. C. N. Vass, M.SC., Ph.D., M.B., Ch.B.)

This decision results from two major developments. The first is an extension of coverage to a wider range of biological research subjects published in journals throughout the world, and the second is that the International Abstracts of Biological Sciences, with the co-operation of the specialist editors selected by the Institute of Scientific Information of the Academy of Sciences of the U.S.S.R. will include, as from the January 1957 issue, translations of the important Russian papers abstracted in the *Referativny Zhurnal Biologii* (Soviet Biological Abstracts) and *Referativny Zhurnal Biologischekoi Khimii* (Soviet Abstracts of Biological Chemistry), to be published simultaneously with their appearance in Russian.

International Abstracts of Biological Sciences abstracts the world literature in the following fields: Anatomy, Animal Behaviour, Biochemistry, Biophysics, Cytology, Embryology, Endocrinology, Epidemiology, Experimental Biology, Genetics, Haematology, Histochemistry, Histology, Immunology, Microbiology, Nutrition, Odontology, Parasitology, Pathology, Pharmacology, Physical Anthropology, Physiology, Radiation Effects, Toxicology and Viruses.

ANNUAL REPORT OF THE BOMBAY NATURAL HISTORY SOCIETY FOR THE YEAR ENDING 31st DECEMBER 1955

President

DR. HAREKRUSHNA MAHTAB, *Governor of Bombay*

Vice-Presidents

Major-General Sir Sahib Singh Sokhey, I.M.S.
Rev. Fr. H. Santapau, S.J.
Mr. Sálim Ali.

Executive Committee

Prof. S. P. Agharkar, M.A., Ph.D., F.L.S., F.N.I. ...	*Poona*
Mr. J. A. Singh, I.F.S.	
Mr. J. I. Alfrey, F.R.E.S.	*Bombay*
Mr. G. V. Bedekar, I.C.S.	
Prof. F. R. Bharucha, D.Sc., F.N.I.	
Mr. R. E. Hawkins	
Dr. C. V. Kulkarni, M.Sc., Ph.D.	
Mr. D. N. Marshall	
Mr. D. J. Panday	
Mr. D. E. Reuben, I.C.S. (Retd.)	
Mr. Humayun Abdulali (*Hon. Secretary*). ...	
Mr. M. J. Dickins (*Hon. Treasurer*)	

Advisory Committee

Mr. H. G. Acharya, F.R.E.S.	*Ahmedabad*
Sir Chintaman Deshmukh, Kt., C.I.E., I.C.S. ...	*New Delhi*
Rev. Fr. Dr. J. B. Freeman, M.A., L.T., Ph.D., D.D.	*Mysore*
Mr. E. P. Gee, M.A., C.M.Z.S	*Assam*
Dr. S. L. Hora, D.Sc.	*Calcutta*
Col. R. C. Morris, F.R.G.S., F.Z.S.	*Attikan*
Lt.-Col. E. G. Phythian-Adams, O.B.E., F.Z.S., I.A. (Retd.)	*Nilgiris*
Dr. Baini Prasad, D.Sc.	*New Delhi*
Dr. M. L. Roonwal, M.Sc., Ph.D., F.N.I., F.Z.S.I. ...	*Dehra Dun*

List of members of the Executive and Advisory Committees elected for the year 1956:

Vice-Presidents

Major-General Sir Sahib Singh Sokhey, I.M.S.
Rev. Fr. H. Santapau, S.J.
Mr. Sálim Ali

Executive Committee

Prof. S. P. Agharkar, M.A., Ph.D., F.L.S., F.N.I. ...	*Poona*
Mr. J. A. Singh, I.F.S.	
Mr. G. V. Bedekar, I.C.S.	*Bombay*
Prof. F. R. Bharucha, D.SC., F.N.I.	
Mr. R. E. Hawkins	
Dr. C. V. Kulkarni, M.SC., Ph.D.	
Mr. D. N. Marshall	
Mr. D. J. Panday	
Mr. D. E. Reuben, I.C.S. (Retd.)	
Mr. Humayun Abdulali (*Hon. Secretary*) ...	
Mr. M. J. Dickins (*Hon. Treasurer*)	

Advisory Committee

Mr. H. G. Acharya, F.R.E.S.	*Ahmedabad*
Sir Chintaman Deshmukh, Kt., C.I.E., I.C.S. ...	*New Delhi*
Rev. Fr. Dr. J. B. Freeman, M.A., L.T., Ph.D., D.D.	*Mysore*
Mr. E. P. Gee, M.A., C.M.Z.S.	*Assam*
Col. R. C. Morris, F.R.G.S., F.Z.S.	*Attikan*
Lt.-Col. E. G. Phythian-Adams, O.B.E., F.Z.S., I.A. (Retd.)	*Nilgiris*
Dr. Baini Prasad, D.SC.	*Dehra Dun*
Dr. M. L. Roonwal, M.SC., Ph.D., F.N.I., F.Z.S.I. ...	*Calcutta*

HONORARY SECRETARY'S REPORT FOR THE YEAR 1955

THE SOCIETY'S JOURNAL

Part 4 of Vol. 52, Parts 1 & 2 of Vol. 53, and the Index to Parts 3 & 4 of Vol. 51 were published during the year under review.

MAMMALS

Three papers were published under this head.

Prof. Bernhard Rensch and K. W. Harde in their 'Growth-Gradients of Indian Elephants' have, after a thorough investigation of fifteen working elephants in Mysore, confirmed the view that *Elephas maximus* is fully grown at the age of about twenty-five years and that after this a slow growth continues up to a high age.

'Hedgehogs of the Desert of Rajasthan' by Daya Krishna and Ishwar Prakash is the result of their study of the distribution and fossorial habits of the two species *Hemiechinus auritus collaris* Gray and *Paraechinus micropus micropus* Blyth. The study was made under a UNESCO scheme to determine the role of vertebrates in the spreading and preserving of desert conditions.

Dr. Angela Nolte in her 'Field Observations on the Daily Routine and Social Behaviour of Common Indian Monkeys with Special Reference to the Bonnet Monkey (*Macaca radiata* Geoffrey)' gives interesting accounts of the Bonnet Monkey, the Rhesus Monkey

Macaca mulatta Zimmerman, and the Common Langur *Semnopithecus entellus* (Dufresne), based on her personal observations during her study tour in India under the leadership of Prof. B. Rensch. At the end of the paper, the author suggests a number of problems for Indian zoologists, the elucidation of which would throw important light on the natural history and social life of Indian monkeys, which are very little known.

BIRDS

Seven papers were published under this head.

Sálim Ali concluded his regional paper on 'The Birds of Gujarat' with Part II, in which he lists 162 more species, together with useful notes under each.

Nepal birds came in for special attention, and the following papers were published:

'Some Birds collected in Langtang Khola, Rasua Garhi Dt. (Central Nepal)' by O. Polunin, recording some 100 species.

'Some Birds from North-Western Nepal' by Col. D. G. Lowndes, which lists 92 species including many that were not met with by Polunin in northern central Nepal.

'More Notes on the Birds of Nepal Valley' by Desireé Proud, is a useful list of 112 species supplementing her previous contributions on the same area in Volumes 48 and 49. An appendix gives the status of the various species as summer and winter visitors and passage migrants, together with dates of their arrivals and departures.

Loke Wan-Tho's 'Two Bitterns in a Penang Marsh' in two parts is a detailed and readable account of the nesting habits of the Yellow and Chestnut Bitterns (*Ixobrychus sinensis* and *I. cinnamomeus*). Mr. Loke has, as usual, illustrated his account with some excellent photographs. The two beautiful coloured plates accompanying the article were generously donated by the author.

S. A. Aktar in 'Bird Migration and Fowling in Afghanistan' describes the several crude but ingenious and highly effective methods by which hundreds of passage migrants like Wrynecks, Bluethroats, Pastors, Quails, and Wild Duck are subjected to wholesale slaughter, while passing through Afghanistan during the winter months.

REPTILES & AMPHIBIANS

Only two herpetological papers were published.

Under 'A New Form of the Burrowing Snake *Uropeltis macrolepis* (Peters) from Mahableshwar' V. K. Chari describes a new race, *mahableshwarensis,* differentiated on lepidosis.

'*Nyctibatrachus humayuni,* A new Frog from the Western Ghats, Bombay' by J. L. Bhaduri and Miss M. B. Kripalani, is the description of a new species obtained at Khandala supplemented with field notes by Humayun Abdulali, the collector.

FISH & FISHERIES

Four papers were published in this section.

S. L. Hora in his 'Tectonic History of India and its Bearing on Fish Geography' explains how tectonic history is helpful in establishing geographical distribution of freshwater fishes, the study of which has been greatly neglected in the past. The mode of dispersal of fishes, Hora states, is dependent on drainage patterns, river captures, flood plains and other phenomena which help in the commingling of waters of different drainage systems. Dr. Hora commends to Indian fish-geographers the use of 'The Structural and Tectonic History of India' published by Dr. M. S. Krishnan, Director of the Geological Survey of India, in a recent memoir in their Piscine Geographical Studies.

P. N. Saranghdhar in his 'Comparative Observations on the Placenta and Foetal Nutrition in Elasmobranchs and Mammals' gives the results of his study of over a dozen elasmobranchs of Bombay in comparison with mammalian placentae. In the light of this comparison an attempt is made to interpret the mechanism of the yolk sac and the yolk sac placenta, the early or late formation of which in this class of fish seems to be influenced by the initial quantity of yolk in the mature ovum.

In 'Notes on a Collection of Fish from the Headwaters of the Bhavani River, South India', S. Rajan lists 48 species of fish from two collections made at different periods in 1953 in the Bhavani and Moyar rivers and some of their tributaries. Detailed taxonomic notes, together with ranges or distribution of 8 species are given.

'Trout Fishing in Kashmir' by Philip K. Crowe is an interesting account of the author's fishing experiences during his 17-day stay in Kashmir. The various localities fished, and the number and weight of fish caught are tabulated, which enhances the value of the paper.

INVERTEBRATES

The following papers were published in this section:

Insects:

'Miscellaneous Notes on Indian Butterflies' by D. F. Sanders.

'A Note on *Apanteles flaviceps* Cam., a Braconid Parasite of the Cholam Stem Borer *Chilo zonellus* Swinh.' by K. C. Chandy.

'Bionomics of *Urentius echinus* Dist. (Hemiptera—Heteroptera: Tingidae), an Important Pest of Brinjal (*Solanum melongena* L.) in North Gujarat' by R. C. Patel and H. L. Kulkarny.

'Some Notes on the Rice Gall-Fly—*Pachidiplosis oryzae* (W.-M.) by M. Q. Khan and D. V. Murthy.

'The "Slug" Caterpillar—*Parasa lepida* Cram. and its Control' by K. P. Ananthanarayanan and E. V. Abraham.

'Biology and Ecology of Oriental Termites (Isoptera) No. 3, Some Observations on *Neotermes gardeneri* (Snyder) [Family Kalotermitidae]' by M. L. Roonwal and P. K. Sen Sarma.

Arachnids:—

'*Ixodes kerri,* a New Species of Tick from a Flying Squirrel from Southern India (Acarina: Ixodidae)' by T. Ramachandra Rao.

'Habits and Habitat of Some Common Spiders found in Western India' by T. V. Subrahmaniam, which deals with 22 different species of common spiders in Bombay and other districts in Western India, including Cochin and Travancore.

Crustaceans & Molluscs:

R. Altevogt in 'Some Studies on Two Species of Indian Fiddler Crabs *Uca marionis nitidus* (Dana) and *Uca annulipes* (Latr.)' published the results of his study of the behaviour of these fiddler crabs in their habitat on the beach at Bandra, Bombay. The paper, as well as the field study upon which it is based, is a model for investigations of this type.

'Some Indian Land Snails' by Frau Prof. Ilse Rensch reports on 27 species collected during her recent trip to India, in three different localities, namely, the Western Himalayas, the Western Ghats and the hills of South Mysore. The paper describes a new race *Pyramidula rupestris sálimalii,* from the Chakrata-Deoban area of the Western Himalayas on proportional characters of the shell.

In 'Marine Organisms Injurious to Submerged Timber in the Bombay Harbour' V. C. Palekar and D. V. Bal list the species of Shipworms (*Teredo*) and 'Piddocks' (*Bankia*) found in the course of their survey of marine borers conducted during 1953-54.

BOTANY

Six papers were published.

'A New Species of *Chlorophytum* from Salsette Island' by Fr. Santapau and R. R. Fernandes describes the new species *borivlianum.*

'A Botanical Excursion to North Kanara, Bombay State, in May 1954' is the diary of an excursion undertaken by Fr. Santapau and some of his colleagues with the object of studying and collecting medicinal plants in North Kanara. Species of plants met with in various localities have been listed, adding greatly to the usefulness of the paper.

'The Botanical Exploration of the Krishnagiri Park, Borivli, near Bombay' is a summary of the results of a botanical survey carried out by Fr. Santapau and Miss Aban J. Randeria (who was awarded the Society's natural history grant). It gives a general description of the terrain, climatic data and rainfall, temperature and humidity, and the vegetation of the area. Our thanks are due to the Milk Commissioner of Bombay for donating the cost of the coloured plate which accompanies the paper. Reprints in the form of a brochure are available with the Milk Commissioner, Wakefield House, Ballard Estate, Bombay, and should prove of interest and value to students and visitors to the park.

Parts III & IV of the serial 'New Plant Records for Bombay', by Fr. Santapau and C. Saldanha, record 9 species not hitherto known to occur in our area.

In 'A New *Polygala* from South India' S. K. Mukerjee describes his new species *ramaswamiana.*

WILD LIFE

Five interesting papers were published on wild life and wild life preservation, a subject which of late has been receiving the special attention of the Society.

R. C. Morris and Sálim Ali, who were delegated by the Society at the request of the Kashmir Government to review the position of wild life in the State and recommend measures to preserve the game animals, particularly the Kashmir Stag, published their report and recommendations—'Game Preservation in Kashmir: Report and Recommendations of the Bombay Natural History Society's Delegation, October 1952'. This report, which was submitted to the Kashmir Government on the completion of the survey tour, contains among other practical suggestions and recommendations one to declare the Black Bear 'vermin' in view of the unwarranted increase in its numbers and its ravages on young deer. The introduction of foreign animals like the Elk and the Red Deer is discouraged in the absence of an adequate knowledge of the ecology of these two animals. It is not known how far the recommendations have been implemented by the Kashmir Government.

Part II of E. P. Gee's 'The Management of India's Wild Life Sanctuaries and National Parks' and another contribution by him on 'The Function of Zoological Gardens in the Preservation of Wild Life' were published. The author, who has been intimately associated with the problem of wild life preservation in our country and has visited almost all the Indian wild life sanctuaries as also many abroad, lays down rational definitions of zoological gardens, zoological parks, municipal parks, wild life sanctuaries, and national parks, so as to remove the prevailing uncertainties and misconceptions regarding the exact character and functions of the various types of parks found in the world. Observations made during his visits to the sanctuaries in Assam, Bengal, Madhya Pradesh, Uttar Pradesh, and Mysore are detailed, and the paper is illustrated by some of his beautiful photographs of wild life. Mr. Gee remarks that India possesses several advantages not enjoyed by other countries in that she has very fine tree forests, mountain scenery, and grand rivers, many of which are wild life centres of first-rate national park potentiality, holding many interesting and beautiful species of mammals and birds not found elsewhere in the world.

In the second article, while discussing the functions and management of zoological gardens and zoological parks, Mr. Gee lists a number of animals on the danger list and suggests that efforts should be made to breed them in zoological parks for subsequent release and boosting of their natural populations in depleted areas.

Two annual reports (1953) of the respective Regional Secretaries on wild life in the Western and Southern Regions were published. In the former, R. S. Dharmakumarsinhji reviews the position in several States in his region and recommends the formation of touring Wild

Life Committees to assess the wild life population from time to time in a given locality. Mr. Y. R. Ghorpade mentions the species of animals in the Eastern Region which are in urgent need of the strictest protection. These include Great Indian Bustard, Hunting Leopard, Nilgiri Tahr, Nilgiri Black Langur, Malabar Squirrel, Four-horned Antelope, Chinkara, and Blackbuck.

MISCELLANEOUS NOTES

96 notes covering all branches of natural history were published. This section of the *Journal*, as usual, is very popular with the readers, and contributions of likely interest from members are most welcome.

SCIENTIFIC EXPEDITIONS

No major expeditions were undertaken during the year under report, but several short collecting trips were made to different localities, which resulted in considerable accessions, particularly in specimens of amphibians.

NATURE EDUCATION SCHEME

This scheme, which has completed its ninth year, has become increasingly popular with schools in view of its useful activities in spreading interest in natural history among teachers and children.

In the series 'Glimpses of Nature' the Kannada edition of 'Our Birds' (No. 1) and a second impression of the English edition were published.

It is hoped that the Government of Bombay will be pleased to retain the Society's Nature Education Scheme as a permanent feature of the State's educational programme so that adequate long-term planning can be undertaken. Its present activities include guided tours to places of natural history interest like the Natural History Section of the Prince of Wales Museum, the Taraporevala Aquarium, and the Victoria Gardens, as also field-trips in the environs of the city, the starting of Nature Study Clubs in schools, arranging film shows and talks on nature, and publication of simple illustrated booklets.

PUBLICATIONS

The 5th edition of 'The Book of Indian Birds' by Sálim Ali was published during the year. It now contains 56 plates in colour (depicting 224 species), 3 in line and 22 in half-tone.

'Butterflies of the Indian Region' by M. A. Wynter-Blyth is making satisfactory progress and there is every hope of its publication in the course of 1956.

REVENUE ACCOUNT

Total receipts during the year amounted to Rs. 51,791-4-3, which includes grants from the Government of India, Rs. 8,000, and Government of Bombay, Rs. 4,000, as compared with Rs. 37,593-6-8 during the previous year. It will be noted that this increase in total revenue is due to our new publications 'The Book of Indian Birds' (5th edition), 'Some Beautiful Indian Trees' (2nd edition) and 'Some Beautiful Indian Climbers and Shrubs'.

Sales of the Society's publications were appreciably higher than last year.

The following is a comparative statement showing the different sources of revenue received in 1954 and 1955:

	Revenue in 1954	Revenue in 1955	Increase in 1955	Decrease in 1955
	Rs. A. P.	Rs. A. P.	Rs. A. P.	Rs. A P.
Subscriptions ...	20,418 0 0	20,428 0 0	10 0 0	—
Entrance Fees ...	1,412 0 0	1,372 0 0	—	40 0 0
Publications :				
Books ...	5,691 0 0	10,210 0 0	4,519 0 0	—
Journals ...	1,634 0 0	3,320 0 0	1,686 0 0	—
Sundries, Taxidermy, Advertisement, etc.	346 0 0	352 0 0	6 0 0	—
Interest on Investments	4,092 0 0	4,109 0 0	17 0 0	—
Grants :				
Govt. of India ...	—	8,000 0 0	8,000 0 0	—
Govt. of Bombay ...	4,000 0 0	4,000 0 0	—	—
Total ...	37,593 0 0	51,791 0 0	14,238 0 0	40 0 0

The net increase in 1955 as compared with 1954 was Rs. 14,198.

The total number of members on our books as at 31st December 1955 was 1,152, of whom 233 were life members. Subscriptions for 1955 have so far been received from 665 members. During the year 70 new members joined, 2 life members and 4 ordinary members died, 5 ordinary members became life members, and 22 ordinary members resigned.

STAFF

The Committee wishes to record its appreciation of the willing co-operation of the entire staff in the activities of the Society.

ACKNOWLEDGEMENTS

The Committee's thanks are due to Mr. P. M. D. Sanderson who continues to look after the Society's interests in the U.K.

APPENDIX TO THE HONORARY SECRETARY'S REPORT COVERING THE PERIOD JANUARY TO AUGUST 1956

This report covers the current year and is supplementary to that for the year ended 31st December 1955, copies of which have been handed out to you.

The April *Journal* has already been issued and the August number should soon be available.

Since 1st January, 33 new members have joined against which 4 died and 11 resigned, making a total of 936 ordinary members and 233 life members on our books.

The Society's recent publications, THE BOOK OF INDIAN BIRDS and the two plant books, viz. SOME BEAUTIFUL INDIAN TREES and SOME BEAUTIFUL INDIAN CLIMBERS AND SHRUBS, are proving popular and selling well, a fair proportion of the orders, particularly for the plant books, coming in from abroad where they have been very favourably reviewed.

We hope to have ready before the end of this year the long-overdue butterfly book and also reprints of the wall chart for the identification of Poisonous Snakes in English, as well as editions in Gujarati and Marathi. This chart has proved of great usefulness in hospitals and dispensaries throughout the country.

We gratefully acknowledge a grant of Rs. 3,000 from the Sir Dorabji Tata Trust to make awards for field work in natural history. Nineteen applications were received and the amount has been divided amongst 8 selected applicants whose studies cover subjects varying from the life cycle and ecology of several branchiopods found on the Panchgani Tableland to a trip into East Nepal for the collection of plants.

It is hoped that the facility will enable the recipients to produce useful results and that these opportunities for field work will help them to cultivate and establish a permanent interest in field biology.

The scientific work of the Society is greatly hampered by the fact that its collections are presently housed in the Prince of Wales Museum while the reference library and offices are a quarter of a mile away. An ambitious plan for the establishment of a National Institute of Natural History in Bombay under the Second Five Year Plan has, unfortunately, failed to find the necessary support from the Government of India, but a more modest scheme for housing the Society's offices and invaluable research collections in a new extension on the Museum's premises is now under negotiation, and we hope that it will be possible to arrive at some suitable arrangement whereby our unique study material will be made more easily accessible to research workers, and at the same time saved from the deterioration which they are now unavoidably incurring.

The following 64 members have joined since the last Annual General Meeting:

FROM 17TH AUGUST TO 31ST DECEMBER 1955

Lt.-Col. S. A. H. Granville, Pachmarhi; Mr. N. A. G. Brooks, Bombay; Mr. S. R. Chowdhuri, Bombay; Dr. Baron von Maydell, Germany; H. E. The Right Hon'ble Mr. Malcolm Macdonald, New

Delhi; Mr. Norman Andrew, Birmitrapur; Rev. L. H. Cramer, Italy; Mr. K. W. H. Adlam, Coorg; Mrs. M. F. Tessier-Yandell, Calcutta; The Chief Forest Officer, North-East Frontier Agency, Tirap (Ledo), Assam; Mr. H. K. Dang, Letekunjan, Assam; Mr. Jan Roger Van Oosten, California; The Librarian, Gujarat University Library, Ahmedabad; Mr. Hamid Wali Mohamad, Nairobi; Mr. Merwan Chamarbagwalla, Bangalore; Shri Chhatrasalji H. H. The Thakore Saheb of Limbdi; Mr. Keser Singh, Jaipur; The Principal, Alagappa College, Karaikudi; Mr. M. Obaidullah, Bettiah; Rev. J. Pallithanam, S.J., Madras; The Principal, Government Arts College, Cuddapah; The Conservator of Forests, Northern Circle, Madhya Bharat; Mr. A. H. Paul, Hoogrijan, Upper Assam; Mr. Henry Penn Wenger, Detroit; Brig. S. T. Apcar, Nilgiris; The Superintendent, Delhi Zoological Park, New Delhi; Dr. William H. Moore, California; Mr. Arjan Jairamdas, Shillong; Mr. Sris Banerji, Bhagalpur City; Mr. H. Bradley Martin, New York; Dr. K. K. Tiwari, Calcutta.

FROM 1ST JANUARY TO 15TH AUGUST 1956

Major A. N. Weinman, Ceylon; Miss M. T. Leveque, France; The Chief Conservator of Forests, Nagpur; Mr. Goverdhandas Roopchand Kirpalani, Bombay; Miss M. G. York, Pithoragarh; The Dy. Director, Soils & Crops, Damodar Valley Corporation, Hazaribagh; Rev. Richard Lane-Smith, S.J., Jamshedpur; Mrs. H. M. Adcock, Bombay; The Principal, Government College, Chandigarh; Mr. A. R. Crampton, Cachar; The Fisheries Development Officer, M. B. Government, Gwalior; The Librarian, Nagpur University Library, Nagpur; Raja Mohammed Etzad Rasul Khan, Jahangirabad Raj; Mr. I. M. Clyde, Cachar; Mr. Kailash Nath Katiyar, Dehra Dun; Brig. H. G. M. Dunn, New Delhi; Mr. A. Hamish Pirie, Darrang, Assam; Mrs. F. Graham Cooch, Ottawa; Mr. Robert Gordon Peirce, Cochin; Mr. K. R. Sethna, Poona; Mr. J. M. Dalal, Bombay; The Assistant Municipal Commissioner, Poona; Mr. H. V. T. Blackburn, Raipur; Mr. F. H. G. Allen, Penang; Mr. Kishore Jayashankar Gandhi, Bombay; Mr. M. S. Raschid, Rangoon; Mr. H. H. Tyabjee, Bombay; Major J. O. M. Roberts, Gorakhpur; Mr. K. G. Gairdner, Thailand; Mr. J. V. Talcherkar, Jamshedpur; Mr. George F. Townes, South Carolina, U.S.A.; The Principal, St. Joseph's College for Women, Alleppey.

MINUTES OF THE ANNUAL GENERAL MEETING OF THE BOMBAY NATURAL HISTORY SOCIETY HELD IN THE CONFERENCE HALL OF THE B.E.S. & T. UNDERTAKING, ELECTRIC HOUSE, ORMISTON ROAD, BOMBAY, ON WEDNESDAY THE 22nd AUGUST, 1956 AT 6 p.m. WITH DR. HAREKRUSHNA MAHTAB, GOVERNOR OF BOMBAY, IN THE CHAIR

1. The Honorary Secretary's Report for the year ended 31st December 1955 having been circulated was taken as read. The Honorary Secretary then read a supplementary report for the period January to August 1956. (*See* p. 242.)

2. The balance sheet and statement of accounts presented by the Honorary Treasurer were approved and adopted.

3. The Committee's nominations to the Executive and Advisory Committees, as previously circulated to members, were accepted.

On completion of the formal business, Dr. Harekrushna Mahtab, Governor of Bombay and President of the Society, addressed the gathering. He remarked on the deplorable lack of interest in Nature Study among the Indian public, particularly in the case of young people and school children. This lack of interest and of a lively spirit of scientific inquiry was to be attributed largely to the apathy or indifference of the elders at home and of the teachers at school. He stressed the importance of early guidance, and the rich spiritual enjoyment to be derived from a proper appreciation of Nature. In this connection he commended the work of the Nature Education Scheme conducted by the Bombay Natural History Society with the aid of a special monetary grant from the Government of Bombay, and the active and continuing efforts of the Society to promote a general interest in Nature by the publication of popular, well-illustrated books on Indian animal and plant life, and in other ways. The Governor expressed high appreciation of the Society's activities in popularizing the pursuit of natural history, and promised it his full support for furthering this end.

An exhibition of original paintings of Indian birds, flowers, and butterflies, from the Society's collection as well as others kindly lent by Messrs. Thacker & Co. Ltd. and the Oxford University Press, arranged for the occasion by Mrs. V. Gardner-Lewis, was greatly appreciated by the gathering.

CORRECTIONS

Volume 53 (3), page 487 (April 1956), 4th line from bottom *for* U.G. Vaidya *read* V.G. Vaidya.

Page 690 last line. *For* 'the third longest' *read* 'the longest'.

Page 691 the record for circumference is held by 19¼″ (C.R.T. Congreve) item No. 7, and not by No. 11 (Major Goring and C. Theobald) as stated.

BOMBAY NATURAL HISTORY SOCIETY

BALANCE SHEET AS AT 31st DECEMBER 1955

FUNDS AND LIABILITIES		Rs A P	Rs A P
Trust fund or Corpus:			
Life Membership Fund.			
Balance as per last Balance Sheet ...		92,793 10 8	
Add: Amount received during the year ...		2,295 15 0	95,089 9 8
Other Earmarked Funds:			
Expedition Fund.			
Balance as per last Balance Sheet	1,900 0 0		
Less: Expenses during the year	100 0 0		
		1,800 0 0	
Field Work Fund.			
Donation for field work in Natural History by Sir Dorabjee Tata Trust ...	3,000 0		
Less: Expenses during the year	43 9 0		
		2,956 7 0	
Wild Life Fund.			
Donation by Mr. Blickmans		1,000 0 0	
Mammal Survey Fund.			
Balance as per last Balance Sheet	2,604 12 7		
Add: Sales to Pakistan Zoological Survey	1,701 11 0		
	4,306 7 7		
Less: Expenses during the year	678 15 3		
		3,627 8 4	
Reserve for future Publications		18,000 0 0	27,383 15 4
Loans: (Secured or unsecured)			
From Trustees		Nil	
,, Others		,,	Nil
Liabilities:			
For Expenses		73,410 0	
,, Advances (Subscription and Entrance Fees)		1,455 13 0	
,, Rent and Other Deposits... ...		Nil	
,, Sundry Credit Balances ...		4,702 4 0	79,568 8 0
Carried forward ...			2,02,042 1 0

ASSETS			Rs A P	Rs A P
Immovable Properties:				
Investments:				
Rs. 14,000 4% Bombay Port Trust Bonds			10,780 0 0	
,, 15,000 4% Bombay Improvement Bonds ...			11,400 0 0	
,, 36,000 3% Funding Loan 1966-68 ...			35,812 10 0	
,, 25,000 3% Conversion Loan 1946 ...			25,000 0 0	
,, 2,000 3% First Development Loan 1970-75 ...			1,948 12 0	
,, 92,000			84,941 6 0	
(Market value on 31st December 1955 Rs. 83,921-14-0)				
£460 3½% Defence Bonds			6,133 5 4	
			91,074 11 4	
Less: Provision for Depreciation ...			1,000 0 0	
				90,074 11 4
Furniture and Fixtures:				
Balance as per last Balance Sheet ...			2,500 0 0	
Less: Depreciation			312 8 0	
				2,187 8 0
Loans: (Secured):	*Good*	*Doubtful*		
Loan Scholarships ...	Nil	Nil		
Other Loans (to staff) ..	1,050	,,		
			1,050 0 0	
				1,050 0 0
Advances				
To Trustees			Nil	
,, Employees			10,896 6 9	
,, Contractors			Nil	
,, Lawyers			,,	
,, Others			200 0 0	
				11,096 6 9
*Income Outstandings**				
Rent			Nil	
Interest			,,	
Other Income:				
Supplies and Services			6,028 1 0	
Government of Bombay (Grant)			4,000 0 0	
				10,028 1 0
Carried forward ...				1,14,436 11 1

---

*The accounts for interest received are maintained on a cash basis. The interest outstanding as at 31-12-1955 amounts to Rs. 1,196-4-6.

BALANCE SHEET AS AT 31st DECEMBER 1955—(*continued*)

LIABILITIES	Rs A P	Rs A P	ASSETS	Rs A P	Rs A P
Brought forward ...		2 02,042 1 0	Brought forward ...		1,14,436 11 1
Income and Expenditure Account:			*Nature Education Scheme:* (As per statement attached)		2,773 7 9
Balance as per last Balance Sheet ...	51,735 10 6				
Add: Surplus as per Income and Expenditure Account	613 8 3	52,349 2 9	*Stock of Books on hand:* (At cost or under) as certified by the Honorary Secretary		71,643 9 0
			Cash and Bank Balances:		
			(*a*) 1. In Current Account with National Bank of India, Ltd., Bombay ...	23,246 7 11	
			2. With National Bank of India, Ltd., London (£520-11-6)	6,941 0 0	
			3. Fixed Deposit Account with National Bank of India, Ltd., Bombay ...	35,000 0 0	
			(*b*) With the Trustee	Nil	
			(*c*) With the Cashier	350 0 0	65,537 7 11
Total ...		2,54,391 3 9	Total ...		2,54,391 3 9

The above Balance Sheet to the best of my belief contains a true account of the Funds and Liabilities and of the Property and Assets of the Trust.

BOMBAY, *20th August 1956.*

For Bombay Natural History Society
(Sd.) M. J. DICKINS,
Honorary Treasurer,
Trustee.

As per our report of even date.
(Sd.) A. F. FERGUSON & CO.,
Chartered Accountants.

BOMBAY NATURAL HISTORY SOCIETY

NATURE EDUCATION SCHEME

Receipts and Payments Account for the year ended 31st December 1955

RECEIPTS	Rs	A	P	PAYMENTS	Rs	A	P
To Grant from Government of Bombay for 1954/55	5,920	0	0	By Balance due to the Society as per last Balance Sheet ...	3,382	14	3
,, Nature Study Pamphlets—Sales	966	13	0	,, Cost of Nature Study Pamphlets	776	10	9
,, Balance being amount due to the Society	2,773	7	9	,, Salary of Nature Education Organiser	5,055	0	0
				,, General Expenses (Stationery, Conveyance, etc.) ...	314	10	3
				,, Postage	131	1	6
Total ...	9,660	4	9	Total ...	9,660	4	9

BOMBAY, *20th August 1956.*

(Sd.) A. F. FERGUSON & CO.,
Chartered Accountants.

BOMBAY NATURAL HISTORY SOCIETY

SCHEDULE IX [Rule 17 (1)]

Dr. INCOME AND EXPENDITURE ACCOUNT FOR THE YEAR ENDED 31st DECEMBER 1955 *Cr.*

Expenditure	Rs A P	Rs A P
To *Expenses in respect of Properties:*		
Rates, Taxes, Cesses	Nil	
Repairs and Maintenance	,,	
Salaries	,,	
Insurance	,,	
Depreciation (by way of vision or adjustments)	,,	
Other Expenses	,,	
,, *Establishment Expenses:*		Nil
Salaries (including Dearness Allowance)	19.489 0 0	
Society's contribution to Staff Provident Fund	949 5 0	
Rent	2,400 0 0	
Postage	1,205 2 0	
Printing and Stationery...	690 4 9	
Editor's Travelling Expenses	1,000 0 0	
		25,733 11 9
Remuneration to Trustees:		Nil
,, *Legal Expenses:*		100 0 0
,, *Audit Fees:*		250 0 0
,, *Amounts written off:*		
Bad Debts	53 6 0	
Loan Scholarships	Nil	
Irrecoverable rents	,,	
Other items	,,	
		53 6 0
,, *Miscellaneous Expenses:*		
General Charges	1,236 0 1	
Fire Insurance	150 0 0	
Provision for Sales-Tax	550 0 0	
		1,936 0 1
,, *Depreciation:*		1,312 8 0
,, *Amount transferred to Reserve or Specific Funds:*		
Reserve for future publications ...		3,500 0 0
Carried forward ...		32,885 9 10

Income	Rs A P	Rs A P	Rs A P
By *Rent:* Accrued		Nil	
Realised		,,	Nil
,, *Interest (Accrued and realised):*			
On Securities—Realised...		3,252 11 0	
,, Bank Account—Realised		855 14 0	4,108 9 0
,, *Dividend*			Nil
,, *Donation in cash or kind*			,,
,, *Grants:*			
Government of India		8,000 0 0	
Government of Bombay		4,000 0 0	12,000 0 0
,, *Income from other sources:*			
Subscriptions		20,428 5 3	
Entrance Fees		1,372 0 0	21,800 5 3
,, *Publications:*			
Journal Sales		3,319 15 0	
Books etc. Profits:			
Book of Indian Birds		2,327 6 6	
Book of Indian Animals...		2,377 5 6	
Some Beautiful Indian Climbers and Shrubs		2 316 11 0	
Some Beautiful Indian Trees		864 6 6	
Circumventing the Mahseer and other sporting Fish		361 7 0	
Calendars		2,222 12 6	
Taxidermy, etc.		78 10 6	
Other Publications		273 15 0	
		14,142 9 6	
Less: Loss on:	Rs A P		
Game Birds of India ...	152 11 6		
Indian Molluscs	107 8 0	260 3 6	13,882 6 0
Carried forward ...			51,791 4

SCHEDULE IX [Rule 17 (1)]—(*continued*)

Dr. *INCOME AND EXPENDITURE ACCOUNT FOR THE YEAR ENDED 31st DECEMBER 1955—(continued)* *Cr.*

Expenditure	Rs A P	Rs A P	Income	Rs A P	Rs A P
Brought forward ...		32,885 9 10	Brought forward ...		51, 91 4 3
To *Expenditure on objects of the Trust :*					
(*a*) Religious	Nil				
(*b*) Educational—Journal expenses ...	16,747 8 8				
Library	1,514 9 6				
Natural History Award ...	Nil				
(*c*) Medical relief	,,				
(*d*) Relief of poverty	,,				
(*e*) Other charitable objects ...	,,	18,292 2 2			
,, Surplus carried to Balance Sheet ...		613 8 3			
Total ...		51,791 4 3	Total ...		51,791 4 3

Bombay, *20th August 1956.*

As per our report of even date
(Sd.) A. F. FERGUSON & Co.,
Chartered Accountants.

For Bombay Natural History Society
(Sd.) M. J. DICKINS,
Honorary Treasurer
Trustee
20-8-1956

PRINTED AND PUBLISHED BY V. M. PHILIP AT THE DIOCESAN PRESS
18 CHURCH ROAD, VEPERY, MADRAS—20-12-1956. C6466
EDITORS: SALIM ALI, AND H. SANTAPAU
114 APOLLO STREET, FORT, BOMBAY

NOTICE TO CONTRIBUTORS

Contributors of scientific articles are requested to assist the editors by observing the following instructions:

1. Papers which have at the same time been offered for publication to other journals or periodicals, or have already been published elsewhere, should not be submitted.

2. The MS should preferably be typed (double spacing) on one side of a sheet only, and the sheets properly numbered.

3. All scientific names, to be printed in italics, should be underlined. Both in zoological and in botanical references only the initial letter of the genus is capitalized. The specific and sub-specific names always begin with a small letter even if they refer to a person or a place, e.g., *Anthus hodgsoni hodgsoni* or *Streptopelia chinensis suratensis* or *Dimeria blatteri*.

4. Trinomials referring to subspecies should only be used where identification has been authentically established by comparison of specimens actually collected. In all other cases, or where identification is based merely on sight, binomials should be used.

5. Photographs for reproduction must be clear and show good contrast. Prints must be of a size not smaller than 3¼×2¼ inches (No. 2 Brownie) and on glossy glazed paper.

6. Text figures, line drawings and maps should be in Indian ink, preferably on Bristol board.

7. References to literature should be placed at the end of the paper, alphabetically arranged under author's name with the abridged titles of journals or periodicals underlined (italics), and titles of books *not* underlined (roman type), thus:

Roepke, W. (1949): The Genus Nyctemera Hübner. *Trans. ent. Soc. Lond.*, **100** (2): 47-70.

Prater, S. H. (1948): The Book of Indian Animals, Bombay.

Titles of papers should not be underlined.

8. Reference to literature in the text should be made by quoting the author's name and year of publication, thus: (Roepke, 1949).

9. Synopsis: As recommended by the Royal Society Scientific Information Conference (July 1948), the editors consider it desirable that each scientific paper be accompanied by a synopsis appearing at the beginning, immediately after the title. The synopsis should be factual. It should convey briefly the content of the paper; draw attention to all new information and to the author's main conclusions. It should also indicate newly observed facts, the method and conclusions of an experiment, and if possible the essential points of any new finding, theory or technique. It should be concise and normally not exceed 200 words.

When the synopsis is completed it should be carefully revised by the author to clarify obscurities, and further compressed wherever possible without detracting from its usefulness.

114 Apollo Street, Fort,
Bombay 1

EDITORS,
JOURNAL OF THE BOMBAY NATURAL HISTORY SOCIETY

THE SOCIETY'S PUBLICATIONS

Mammals

The Book of Indian Animals, by S. H. Prater. With many coloured and black and white plates. 2nd (revised) edition. (*In preparation*)

Birds

Game Birds of India, by E. C. Stuart Baker. Vol. III. Pheasants, 1st Edition. **Rs. 20**
(*Price to Members Rs.* 15)

The Book of Indian Birds, by Sâlim Ali. With 56 coloured and 22 black and white plates, 5th (new) edition, revised and enlarged. **Rs. 20**
(*Price to Members Rs.* 16)

Fish

Circumventing the Mahseer and Other Sporting Fish in India and Burma, by A. St. J. Macdonald. With coloured and black and white plates. **Rs. 15**
(*Price to Members Rs.* 12)

Miscellaneous

Some Beautiful Indian Trees, by Blatter and Millard. With many coloured and monochrome plates. 2nd (revised) edition. **Rs. 20**
(*Price to Members Rs.* 16)

Some Beautiful Indian Climbers and Shrubs, by Bor and Raizada. With many coloured and monochrome plates. **Rs. 22**
(*Price to Members Rs.* 17-8)

Butterflies of the Indian Region, by M. A. Wynter-Blyth. With 27 coloured and 45 monochrome plates. **Rs. 28**
Available from January 1957. (*Price to Members Rs.* 22-8)

Indian Molluscs, by James Hornell. With 2 coloured and many monochrome plates, and text figures. **Rs. 6**
(*Price to Members Rs.* 4-8)

Glimpses of Nature Series Booklets :
OUR BIRDS, 1 (with 8 coloured plates) in English, Gujarati, Hindi, Kannada and Marathi. **As. 10**
OUR BIRDS, 2 (with 8 coloured plates) in English. **As. 10**
(Editions in provincial languages in preparation)

Wall Chart to distinguish a Wild Dog from a Domestic Dog or Jackal, etc. **Rs. 2-8**

Identification of Poisonous Snakes—Wall charts in English, Gujarati and Mahratti. (*In preparation*)

Back numbers of the Society's Journal. Rates on application.

Obtainable from:

The Honorary Secretary,
Bombay Natural History Society,
114 Apollo Street, Bombay 1.

London Agents:

Messrs. Wheldon & Wesley Ltd.,
83/84 Berwick Street,
London, W. 1.

TERMS OF MEMBERSHIP

Life Members pay an entrance fee of Rs. 25 and a life membership fee of Rs. 500.

Ordinary Members pay an entrance fee of Rs. 25 and an annual subscription of Rs. 30.

The subscription of members elected in October, November and December covers the period from the date of their election up till the end of the following year.

MEMBERS RESIDING OUTSIDE INDIA

The terms are the same for members living outside India. Such members should pay their subscriptions by means of orders on their Bankers to pay the amount of the subscription, plus postage—in all Rs. 32-2-0—to the Society in Bombay on the 1st January in each year. If this cannot be done, then the sum of £2-8-0 should be paid annually to the Society's London Bankers—The National Bank of India, Bishopsgate Street, London, E.C.

JOURNAL OF THE
BOMBAY NATURAL HISTORY SOCIETY

Vol. 54, No. 2

Editors
SÁLIM ALI & H. SANTAPAU, S.J.

SMITHSONIAN
AUG 29 1957
LIBRARY

APRIL 1957

Rs. 15

JOURNAL OF THE
ZOOLOGICAL SOCIETY OF INDIA

Published bi-annually, containing original papers and reviews in all branches of Pure and Applied Zoology

Annual subscription per volume of two issues:
Foreign: Rs. 22; Inland: Rs. 20.

A few back numbers are also available, subject to prior sale.

A few pages are reserved for advertisements at rates available from the Honorary Treasurer.

Reprints of a few papers of the Indian Helminthologist, the (late) Dr. G. D. Bhalerao, *Indian Journal of Helminthology* and Prof. Thapar Sixtieth Birthday Commemoration Volume, 1953, could also now be had from the Office of the Honorary Treasurer, Dr. B. S. Chauhan, 34, Chittaranjan Avenue, Calcutta-12, India.

All orders, remittances and communications regarding above should be addressed to the Honorary Treasurer.

RECENT PUBLICATIONS OF THE BOMBAY NATURAL HISTORY SOCIETY

Some Beautiful Indian Trees by Rev. E. Blatter, S.J., and W. S. Millard. Second edition. Revised and brought up-to-date. With 31 coloured and 37 monochrome plates, and numerous text-figures. Price Rs. 20.
(to members Rs. 16).

Some Beautiful Indian Climbers and Shrubs by N. L. Bor and M. B. Raizada. With 31 coloured and 99 half-tone plates, and numerous text-figures. Price Rs. 22.
(to members Rs. 17·50).

The Book of Indian Birds by Sálim Ali. 5th (New) Edition. With 56 coloured plates depicting 224 species, and 22 in monochrome from photographs. Price Rs. 20.
(to members Rs. 16).

CONTENTS OF VOLUME 54, NO. 2

PAGE

HISTORY OF OUR KNOWLEDGE OF THE INDIAN FAUNA THROUGH THE AGES. By H. Srinivasa Rao, M.A., D.SC., F.N.I. (*With two plates*) ... 251

VEGETATION OF HARSH NATH, ARAVALLI HILLS. By N. C. Nair and G. S. Nathawat. (*With a map*) 281

NOTES ON THE HETEROCERA OF CALCUTTA, PART IV. By D. G. Sevastopulo, F.R.E.S. 302

VOICE AND LARYNX IN AFRICAN AND ASIATIC COLOBIDAE. By W. C. Osman Hill, M.D., F.R.S.E., and A. H. Booth. (*With two text figures*) 309

ON A ZOOLOGICAL COLLECTING TOUR OF THE ISLANDS OFF JAFFNA. By P. H. D. H. De Silva. (*With a map*) 322

FURTHER OBSERVATIONS ON THE FAMILY LIFE OF THE FIVE-STRIPED SQUIRREL, *Funambulus Pennanti* WR. By (Mrs.) Aruna Banerji ... 335

THE SHIPWORMS OF SOUTH INDIA WITH A NOTE ON THE BREEDING SEASON OF *Bankia Indica* Nair. By N. Balakrishnan Nair, Ph.D. (*With a plate, three text figures and a graph*) 344

THE ABOMINABLE SNOWMAN. By Swami Pranavananda, F.R.G.S ... 358

A BOTANICAL TRIP TO THE VALLEY OF FLOWERS. By B. N. Ghildyal. (*With a sketch map*) 365

SOME OBSERVATIONS ON THE HABITS OF THE SLENDER LORIS *Loris Tardigradus* (LINNAEUS). By (Mrs.) Swarna Subramoniam, M.SC. (*With five plates*) 387

ON THE MARINE CRABS (DECAPODA : BRACHYURA) OF BOMBAY STATE, PART I. By B. F. Chhapgar, M.SC. (*With one coloured and eleven line plates, and two text figures*) 399

OBITUARY :—

Brigadier W. H. Evans, C.S.I., C.I.E., D.S.O., R.E. 440

REVIEWS :—

1. Features of Evolution in the Flowering Plants (P. V. Bole) ... 442
2. The Sherpa and the Snowman (H. A.) 443
3. Birds of Ceylon. 3. (S. A.) 444
4. An Introduction to the Botany of Tropical Crops (J. A. Ali) ... 444
5. Open Air Guides—Bark (H. Santapau) 445
6. List of Indian Fungi—1952-1956 (H. Santapau) 446
7. Butterflies of the Indian Region (T. N.) 447

AUG 24 1957

PAGE

MISCELLANEOUS NOTES :—

1. Footprints of 'Snowman'. By Swami Pranavananda (p. 448). 2. Hairless Lion Cubs in the Trichur Zoo. By M. Govindankutty Menon (*With a plate*) (p. 450). 3. 'Scent Trails' and 'Pooking' in Tiger. By Capt. K. Boswell (p. 452). 4. Following up Wounded Tiger at night. By Capt. K. Boswell (p. 454). 5. Further notes on the Himalayan Mouse-hare, or Pika (*Ochotona rufescens*). By S. A. Akhtar (p. 455). 6. A note on Insects consumed as food by Squirrels and Birds at Kundri Forest, Palamau District, Bihar. By S. Krishnaswami and N. S. Chowhan (p. 457). 7. Tusks of Indian Elephants. By R. C. Morris (p. 460). 8. Hypnotic Behaviour of a Whiteheaded Babbler (*Turdoides striatus*). By K. K. Neelakantan (p. 460). 9. Drumming of the Malabar Goldenbacked Woodpecker *Brachypternus benghalensis*. By B. Vijayaraghavan (p. 461) 10. Accidental death of a Crimsonbreasted Barbet [*Megalaima haemacephala* (Müller)]. By B. Vijayaraghavan (p. 462). 11. *Halcyon pileata* inland. By F. N. Betts (p. 462). 12. Redlegged Falconet, *Erythropus amurensis* (Radde), near Bombay. By Sálim Ali (p. 463). 13. An incubating Peacock (*Pavo cristatus* Linn.). By Y. S. Shivrajkumar (p. 464). 14. Occurrence of the Ruff and Reeve [*Philomachus pugnax* (Linnaeus)] near Coimbatore. By Editors (p. 464). 15. Rednecked Phalarope (*Lobipes lobatus* Linn.) in Bhavnagar, Bombay State. By Shivrajkumar of Jasdan and R. S. Dharmakumarsinhji (*With a plate*) (p. 465). 16. Some Riddles of Game-bird Migration in Kutch. By H. H. Madansinhji of Kutch (p. 466). 17. The Liver Fluke of the Frog, *Rana tigrina*—a new record of *Mehraorchis ranarum* Srivastava, 1934 (Pleurogenitinae). By R. S. Tandon (p. 468). 18. Ticks from Baluchistan, West Pakistan. By Henry Field (p. 469). 19. Bionomics of the Pumpkin Caterpillar, *Margaronia indica* Saund. By D. G. Sevastopulo (p. 470). 20. A new pest of Screwpine in Kerala : *Agonia fuscipes* Baly (Hispinae, Chrysomelidae). By M. R. G. K. Nair (*With four figures*) (p. 470). 21. A giant form of *Celosia argentea* L. By J. Sakharam Rao (*With a photo*) (p. 474). 22. *Eclipta prostrata*, *E. erecta*, or *E. alba* : Which is the correct name ? By H. Santapau (p. 475). 23. *Alternanthera paronychioides* St. Hil.—A Correction. By H. Santapau (p. 476). 24. *Habenaria panchganiensis*—New name for a Bombay Orchid. By H. Santapau and Z. Kapadia (p. 478). 25. Wild Life Preservation in India : Predator Control and the Introduction of Exotic Species. By C. L. Boyle (p. 478).

GLEANINGS 482
NOTES AND NEWS 488
CORRECTION 489

JOURNAL
OF THE
BOMBAY NATURAL HISTORY SOCIETY

1957 Vol. 54 No. 2

HISTORY OF OUR KNOWLEDGE OF THE INDIAN FAUNA THROUGH THE AGES

BY

H. Srinivasa Rao, M.A., D.SC., F.N.I., F.A.SC., F.Z.S.I.

(*With two plates*)

INTRODUCTION

Long before the dawn of the era of history, man appears to have been a practical biologist, systematising his knowledge of the plants and animals amongst which and on some of which he lived. If the Stone Age evidence of his realistic drawings of the familiar animals around him on rock surfaces in caves is to be believed, the conclusion that he was a fairly competent biologist even twenty thousand years ago is inescapable. In the Neolithic period, he seems to have entered an era of experimental work in the course of which he not only domesticated and tamed several species of common animals around him but attempted successfully various kinds of hybridisation.

In the present account of our knowledge of animal life in India, covering a period of over five thousand years, there is therefore little that man had not already learnt in the preceding centuries and to which he had not given concrete representation in the form of drawings, engravings, etc., although the earlier records are still far from complete. The only justification for the present compilation of the hitherto known but scattered facts is that *en masse* they may furnish a better perspective of animal life in India through the ages than would otherwise have been possible, to the student of biology as well as to the student of the history of biology.

The legends of the tribal peoples and the undying traditions of the Hindu scriptures abound in references to a great variety of animals, with which the common people and the *élite* must have come into contact in their daily lives in their forest retreats and urban settlements.

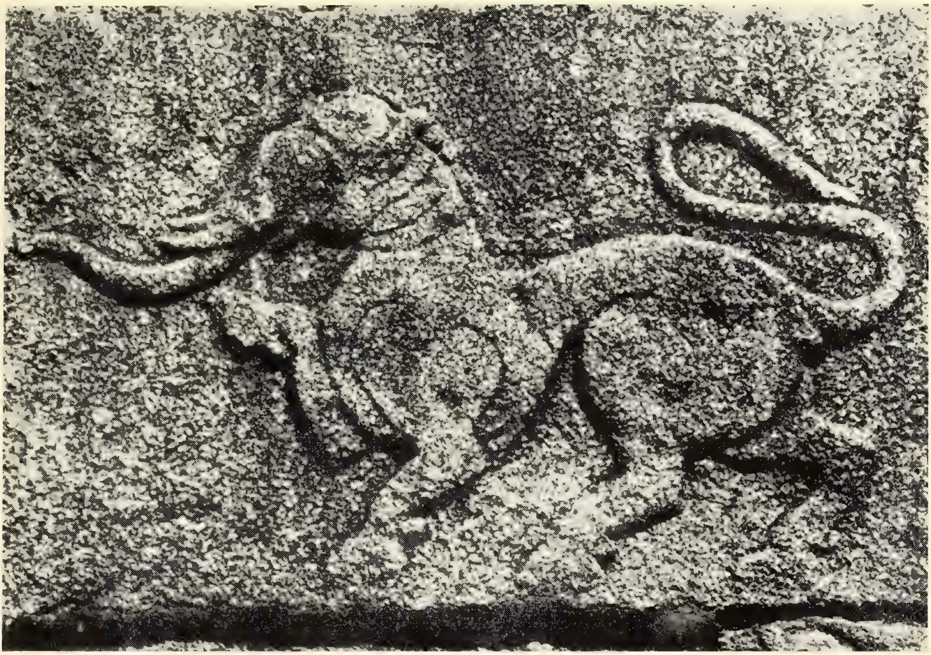
The *avatārās* referred to in the Hindu scriptures are each associated with a common animal or being in a definite, perhaps intentional, chronological sequence of evolutionary significance, from the fish and the turtle, through the boar and the man-lion, to the dwarf or the pigmy in the first five of the *avatārās*. In the next four *avatārās*, which take human form, there seems to be a social significance in the main events of their lives. Bhārgava was an elemental warrior out to decimate the iniquitous Kshatriya, Rāma was the ideal and over-conscientious ruler of a thoroughly democratic people, often merciful and compassionate to a fault to the fallen enemy, Krishna was a born lover, a diplomat, and a true and constant friend, and Bouddha proved himself a typical and uncompromising renouncer or *bairagi* (*vyragi*). The tenth and the last avatārā of Vishnu is predicted to incarnate as a ruthless warrior riding on horseback to wipe out all kinds of iniquity.

The Hindu Trinity and other Gods never disdained the use of animals and their products of various kinds, as their vehicles, ornaments, weapons, etc. Brahma is known to use the white swan as his vehicle, Vishnu the kite (Garuda), and Siva the bull (Nandi). The use of the many-headed serpent (*ādi-sesha*) as the bed, of the Turbinid Conch-shell (*sankha*) as the trumpet, the yellow silk garment (*pītāmbarā*) as the favourite apparel, and the peacock feather as one of the ornaments of Vishnu are well known. The other member of the Trinity, Siva, was more austere and chose the tiger-skin for his apparel and live snakes as a garland or ornament. Ganesh, Yama (the God of Death), and Subrahmanya chose a rodent, a water buffalo, and a peacock respectively as conveyances or *vāhanās*.

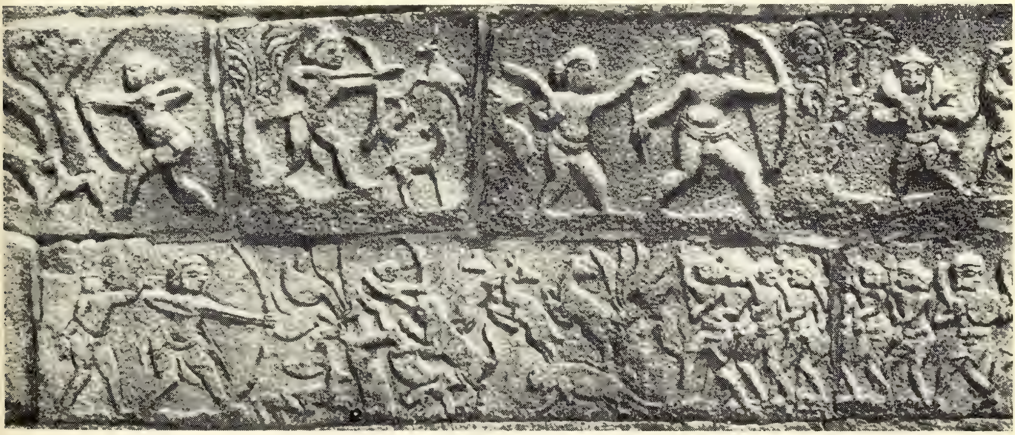
More tangible evidence than is found in the Hindu scriptures of the extent of our knowledge of animal life in the country is provided, however, by the animal remains, seals, earthen ware, and terracotta articles, bearing faithful representations of animal life found in the Indus valley and the adjoining territories of Sind, Baluchistan, and the Punjab.

The legendary or mythical elements of the Indian fauna referred to in the following pages such as the *yāḻi* (the leonine elephant or the bovine-canine lion), the *sarabha* (*eṉkālparavai*), and the *gaṇdabhêrunda* (the two-headed serpent eagle) are perhaps of the same status as the Loch Ness monster of Great Britain and the *yēti* or 'Abominable Snowman' of the snow ranges of the Himalayas, but they seem to have persisted in some cases as a tradition in sculptures or emblems without a hitherto verifiable background. Even the *sārdōl* or *sārdoola*, referred to in Abul Fazl's Memoir as 'smaller than a dog but preys upon lions and other wild beasts', is not represented in sculpture or engraving in any literature that the present author is aware of. Notwithstanding these few instances of imaginative representations or chronicles in our literature from ancient times, a fairly objective view of the knowledge of animals living in a wild or domesticated state in various periods of history or pre-history can be obtained, either from the actual remains where available, or from their representations in sculptures, paintings, engravings, etc., on rock or pottery, and in seals and such-like objects.

There are practically no references to fossil animals, even though the fossil Cephalopod *Ammonites* of the sub-Himalayan region,

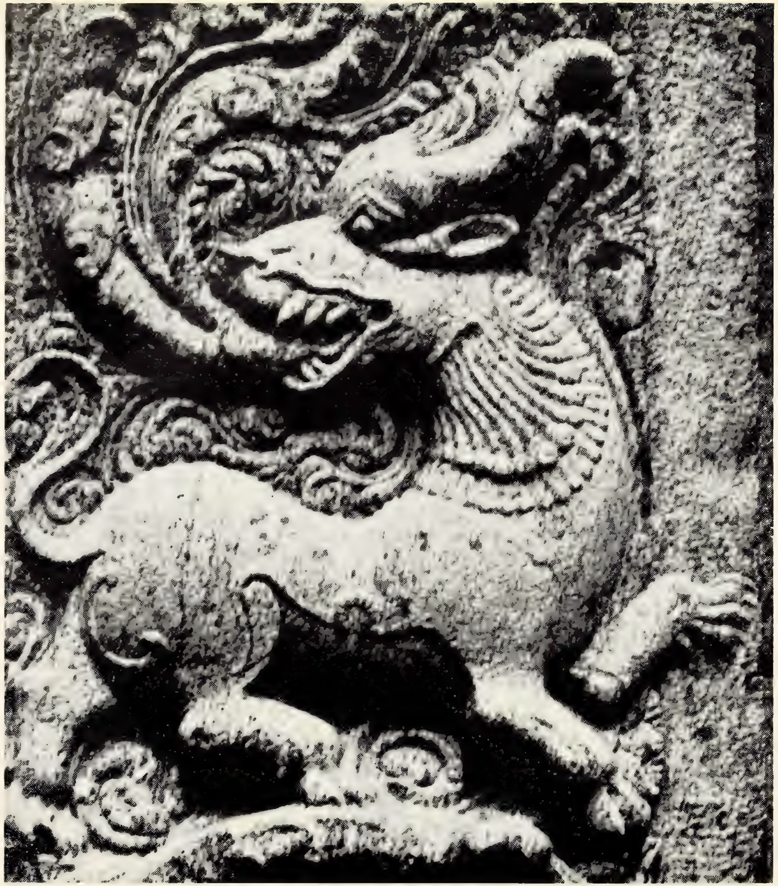


The mythical Yāli with leonine body and elephantine face from a Hampi relief

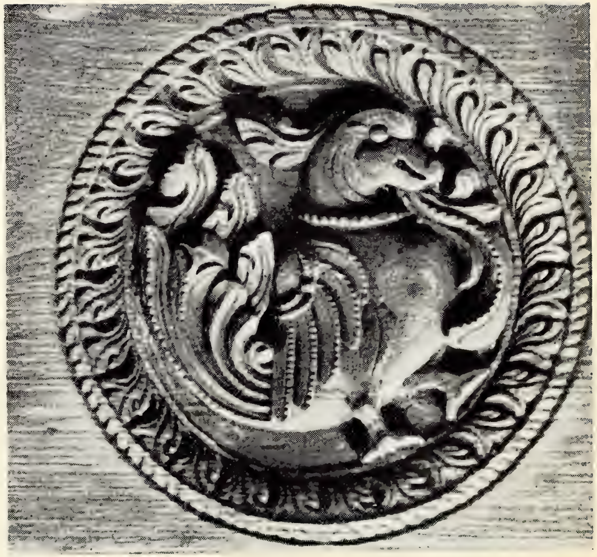


Hunting scenes from the throne platform at Hampi in Mysore depicting antelopes, sambar, and leopards

Photos : The Ruler of Sandur



Another form of the mythical Yāli with leonine body and limbs, mane and tail, but with canine face and bovine horn and ear. From a panel of a 'mantapam' at Madurantakam in Chingleput District, Madras.



A formal Swan with crest and curled plumes and a short neck. From a carving in wood on a doorway in in Chingleput District, Madras.

Photos : *M. Krishnan*

known to Hindu religious tradition as *sāligrām*, is held in veneration as the favourite abode of Mahā Vishnu.

ACKNOWLEDGEMENTS

The present review was undertaken at the suggestion and encouragement of Professor K. A. Nīlakanta Sāstri (formerly Joint Secretary of the Indian History Congress) about the middle of 1952, but its completion was unavoidably delayed for over two years. The author is most grateful to him not only for placing in his hands a good part of the relevant literature on the subject in Sanskrit, Tamil, and English obtained from different sources, but also for patiently going through the manuscript and suggesting many improvements.

The photographs of fabulous animals illustrating this account were kindly lent by Sri M. Krishnan, Madras, who was also good enough to place at the author's disposal a copy of his notes on the fauna of South India as noticed in classical sculpture and ancient Tamil literature. The author wishes to take this opportunity to express his gratitude to Sri Krishnan for his ready assistance.

The author is also thankful to his friend and colleague, Dr. B. S. Guha, former Director of the Government of India Department of Anthropology, for a list of selected references on the fauna of Moghul India.

I. ANIMAL WEALTH OF INDIA IN THE 3RD AND 4TH MILLENIA B.C.

Evidence of animal life in the Indus Valley and the adjoining territories of Sind, Punjab, and Baluchistan has been brought together by a careful study of the actual animal remains found in Mohenjodaro, Harappa, Amri, Nal, Nundara, and Rupar, and of animal representations engraved on seal amulets, and in the figurines and engravings and paintings on pottery and other ware. Actual remains of 39 species of animals including 26 of Vertebrates and 13 of Invertebrates were found at various levels. These may be grouped as follows:—

1. Animals maintained in a state of domestication.	Humped cattle, buffalo, elephant, camel, horse, goat, pig, and fowl.
2. Animals found near human habitations, some of them probably semi-domesticated.	Dog, mongoose, shrew, rat, lizard, and tortoise.
3. Animals caught, probably for use as food.	Pig, crocodile, turtles, tortoise (*Trionyx*, *Chitra*, *Damonia*, and *Batagur*), freshwater fishes (carps, cat fishes *Rita* and *Wallago*) and the marine cat fish *Arius*, probably imported for consumption from the coast.

4. Scutes of turtles, shells of snails, and the skeleton of corals imported for ornament or other uses.	*Batagur* among tortoises *Lamellidens* and *Arca* among bivalve molluscs; *Cypraea* (Cowries), *Eburna*, *Fascioloria*, and *Xanchus* (*Chank*) among gastropod molluscs; and *Favia* among corals.
5. Animal remains imported probably for medicinal purposes.	Horns of deer (*Cervus*, 4 species).
6. Wild animals.	Bear, monkey, jackal, wolf, squirrel, gharial, and parrot.
7. Animal remains occurring fortuitously.	The Clionid sponge, judging from bore holes on Fasciolarid shells, the Polyzoan colonies the markings of which are still to be seen on shells, and the Anatinid bivalves embedded in a mass of madreporarian coral show that conditions in the sea were much the same as they are now.

The elephant (*Elephas maximus*) was probably wild as there is still evidence that in Malwa and Nimar it was so till 1600 A.D. The horse (*Equus caballus*) was the country-bred, while of the humped cattle (*Bos indicus*) there are wild and domesticated forms showing progressive and steady deterioration correlated with the size of teeth and skull. There were the buffalo, the camel, the goat, the sheep, the ass, and the boar. The Kashmir Stag, the Sambar or Rusa Deer, the Spotted Deer, and the Hog Deer which is still an inhabitant of Sind were common. The domesticated fowl was probably much larger in size than modern fowls, judging from the size of the femur and other bones.[1] The presence under fluviatile conditions of the freshwater bivalves, *Lamellidens marginalis* and *Parreysia favidens*, and of the freshwater gastropods, *Indoplanorbis exustus* and *Viviparus bengalensis*, and of the land-snail *Zootecus insularis*, the gharial *Gavialis gangeticus*, the tortoises and turtles, the carps, and cat fishes shows that the faunal elements on land and in water were much the same then as they are now. The chank bangles and cores from which bangles have been sawn show that bangle-making and bangle-wearing were then as much in vogue in western India as now in Bengal and east India.

We may now turn to the representations of animals engraved or painted on seals and pottery and to the figurines. Owing to the bizzare and fanciful forms which have been given to them, the identification of these representations of animals is probably a little more difficult than that of the actual animal remains which rarely, if ever, give room for ambiguity. Apart from engravings of fabulous creatures on seal amulets, the recognisable animals are the cattle, the elephant, the rhinoceros, and the tiger[1] such as are commonly found in damp jungles. The lion which prefers a dry zone such as is now found in the Gir region of Kathiawar does not appear to have figured on seals. Amongst the cattle figure the water buffalo (*Bos bubalus*), the Gaur or bison (*Bos gaurus*), the humped bull or Zebu (*Bos indicus*), and a short-horned humpless bull. The ram, pig, dog, monkey, bear, hare, and squirrel amongst mammals, and the parrot and peacock among birds are found engraved on copper tablets or take the form of figurines, but are never represented on seals. The dog, represented with the collar round the neck, shows it to have been used as a domestic pet and a guard. The short-horned and the humped bulls, the ram, and the rhinoceros were amongst the most popular of the animal figurines, though curiously the cow is altogether omitted, as also the tiger which, according to Piggot (1952), still survives in Sind[2]. The elephant and the fish-eating crocodile (*Gharial*) of the great rivers of India are copied in figurines, though the common pig is omitted.

---

[1] Herodotus, the Father of History, is said to have recorded twenty-three centuries ago that the animals of India, except the horse, were larger than those found elsewhere (Annandale, N. *Journ. Bombay Natural History Society* 29 : 633–642, 1923).

Lion, goat or ibex, birds of various types, and fishes, and even the scorpion are represented in the Sind and Baluchistan ware, the ibex being often used as a decorative motif. Some of the Kulli ware bears painted decorations in the form of a frieze of naturalistic representations of animals and plants. The animal representations include humped cattle, felines in grotesquely elongated forms (which appear to have been copied by modern advertisers of automobiles, motor oils, and lubricants), diminutive stylized goats, conventionalized birds, fish, and even a bloated stag-beetle. The humped cattle are shown as tethered to trees or posts indicating their domestication.

II. ANIMAL LIFE IN THE VEDIC PERIOD (2000 TO 600 B.C.)[3]

For a knowledge of the classification of animal life in the period up to 600 B.C. one has to turn to recorded evidence of such knowledge in the Upanishads, Susrūta Samhita, and other works. The Chāndôgya Upanishad has classified animals on the broad basis of their ovum or seed (*bija*) into three groups: (1) born of eggs (*andaja*), (2) born fully developed or viviparous (*jīvaja*), (3) born of plant-like organisms (*udvijja*). The birds, which belong to the first group, and mammals, which belong to the second group, both of which are used as food by man, appear to have been divided into the following 8 classes depending on their habitat and feeding habits:

1. Carnivorous land quadrupeds and birds such as fall upon their prey with force (*prasaha*).
2. Animals living in marsh or water-logged lands or graze on river banks (*anupa*).

---

[1] The tiger has curiously left no traces of its bones amongst the animal remains excavated in Sind and Baluchistan.

[2] We can trace no authentic record in support of this either for the past or the present. EDS.

[3] Including the age of the Rig Veda (2000 to 1500 B.C.), the age of the Samhitas and Brahmanas (1500 to 800 B.C.), and the age of the old Upanishads (900 to 600 B.C.)

3. Animals living in underground holes or burrows (Rodents and Insectivores—*bhūsaya* or *vilêsaya*).
4. Animals living in freshwater or seawater (*vārīsaya*).
5. Animals living both on land and in water—amphibians (*jalachara*).
6. Animals living on dry and elevated hilly or jungle land, such as deer, etc. (*jangala*).
7. Birds that scatter their food in picking it up (*viskīra*), e.g. crow, bulbul, thrush, pigeon, and other perching birds.
8. Birds that pierce, tear their food (fruits), or torment their prey (worms) with their beak [Birds of prey—vulture, eagle, kite, etc. (*pratudda*)].

The second class *anupa* appears to have been deemed an important class as it is further divided into the following groups:—

1. *kulêchara*—herbivorous quadrupeds frequenting banks of rivers and ponds, including the elephant, the rhinoceros, the buffalo, and the deer.
2. *plava*—floating on water, such as geese, ducks, cranes, etc.
3. *kôsastha*—living in shells (mollusca), including the large gastropods, the Chank (*sankha*) and the smaller gastropods (*sankhanā*), the mussels, and pearl-oysters (*sūkti* and *jalasūkti*), the various types of spiral-shelled land gastropods or snails (*sambuka*, *valluka*, *vōdika*, etc.).
4. *pādina*—aquatic animals with long drawn appendages including the tortoise and turtles (*kūrmā*), the crocodile (*kumbhīra*), the crab (*karkata*), the whale or dolphin (*simsumāra*) with a protruding snout and breathing through a blow-hole out of water.
5. *matsya*—the fishes of seawater and freshwater, amongst which are included the whales (*timi* and *timingila*) and the sharks (*makara*).

The *jangala* were similarly broken up further into arboreal animals [*parnamriga*—ape, monkey, sloth, squirrel, tree cat (*putighasa*), and other similar carnivores], domesticated animals (*grāmya*—horse, mule, ass, camel, goat, sheep, etc.—all non-carnivorous quadrupeds or *akravyāda*), cave-dwelling animals (*guhāsaya*—lion, tiger, panther, bear, wolf, hyena, jackal, wild cat—all carnivorous quadrupeds).

More or less similar notions seem to have prevailed in the classifications of the animal kingdom enunciated by Susrūta, Pātanjali, Prasastapāda, and Chāraka. Susrūta has recognised oviparity, viviparity, and spontaneous generation amongst animals. He put man and the carnivorous (*vijala*) and herbivorous (*pasu*) quadrupeds amongst the viviparous; birds, snakes, turtles, crocodiles, and fish amongst the oviparous; worms, insects (*krimi*, *kīta*, *pipīlika*) amongst those born of moist heat; and frogs and mealy bugs amongst those that are born after metamorphosis. Pātanjali seemed to have been aware of a group of small or minute animals without blood or bones which he classed among the *kshudrajantu*, but as asexually generated. Prasastapāda recognised the asexually generated (*ayōnija*) from those sexually generated by the union of sperm and a germ element (*yōnija*), and amongst the latter the placental viviparous (*jarāyuja*) from the non-placental egg-born (*andaja*) birds, reptiles, fishes, and insects. Chāraka recognised four primary divisions of animals: (1) the viviparous placental quadrupeds and man (*jarayuja*), (2) the oviparous birds, reptiles, and fish (*andaja*); (3) the asexually or spontaneously generated worms, mosquitoes, etc., born of moist heat (*svêdaja* or *usmaja*) and (4) those born of rotting vegetation (*udvijja*).

There is some evidence of a more precise classification in the *Susruta Nāgārjuna*, as in the case of snakes, which are divided into 5 different genera or families, one non-venomous and four venomous including one hybrid and three pure families. The venomous are (1) the hooded cobras (*Naia tripudians* and *N. bungarus*) the *darvikāra*, diurnal, swift, and bearing marks of chariot-wheels, plough, umbrella, goad, or rhombus on the hood; (2) the non-hooded thick-set, slow, nocturnal Vipers (*mandali*) bearing circles or rings on the body; (3) the non-hooded nocturnal Krait (?) bearing coloured markings or dots on the upper parts and sides; and (4) the hybrid *vaikaranja*. The non-venomous (*nirvisha*) family includes the Boidae or python (*ajagara*), and the arboreal colubrine *Dendrophis* (*vrikshêsaya*). The poison of cobras was believed to be most deadly when they were young, and of *mandali* or vipers when middle-aged, and of *rajimats* when aged. The differential action of the venom on animals in the different venomous snakes appears to have been known and is elaborately described.

The Agni and Bhavishya puranas have a number of observations on the structure and habits of snakes, some of which approximate to modern verified and recorded facts while others appear to be fanciful as yet. The latter states that Naiadae (*nāgās*) copulate in the summer months of May and June (*Jyêshtha* and *Āshādha*), gestate during rainy months and bring forth about two hundred and forty eggs in November (*Kārtik*), the majority of which are devoured by the parents, but those that are left break forth from the shell in about two months. Eggs of a golden hue like that of the red *arka* (*Calotropis gigantea*) produce males, those somewhat paler and of an elongate ovoid shape bring forth females, and those of the hue of *Sirīsha* blossom hermaphrodites. The young snakes turn dark on the 7th day, and in a fortnight to three weeks the teeth appear. Poison is formed in the fangs in three weeks and becomes deadly on the 25th night. In six months more they shed the skin. Their crawling on the ground is associated with the folds of the skin on the undersurface expanding and contracting alternately, and appearing as though they had fine filament-like legs. The joints on the skin (scales and scutes) are stated to be 240 in number (sub-caudals excluded). Human beings, oxen, mongooses, boars, cats, peacocks, partridges (*chakôra*), and even a scorpion are stated to be their enemies. The cobras (*nāga*) may live for 120 years, and the non-venomous snakes for 75 years, estimates which are only twice as much as the modern ones ranging from 13 to 30 years or more for all types of snakes as a whole[1].

---

[1] Flower, S. S. Contributions to our knowledge of the duration of life in Vertebrate animals, Parts I to IV. *Proc. Zool. Soc. London.* I and II Fish and Batrachians pp. 247–289 (1925), III and IV Reptiles pp. 911–981, Birds pp. 1365–1422. Mammals *P.Z.S.* I, pp. 145–234. Same author in *P.Z.S.* I (1936), CVII (1937), CVIII (1938).

According to Agnipurana the total number of teeth in a cobra is 32 of which four, two on either side, are venomous and have distinct names (*kālarātri* and *yamadūtika*). The non-grooved hard maxillary teeth accompanying the fangs also seem to have distinct names (*karāli* and *makari*).

The understanding of the classification of animals seems to become more precise and scientific at the beginning of the 1st century A.D. In the Jaina work *Tattvārthadhigama*, Umasvati (*ca.* 40 A.D.) has attempted a classification of the animal kingdom on the number of senses, from the simple to the complex, as follows:—

Invertebrata:

(i) Animals with *two* senses, of *touch* and *taste*, involved in the selection or rejection of food.
(ii) Animals with *three* senses, of *touch*, *taste*, and *smell*, involving the contraction of tissues and appropriation of food.
(iii) Animals with *four* senses, of *touch*, *taste*, *smell*, and *sight*.

Vertebrata:

(iv) Animals with *five* well-developed senses of *touch*, *taste*, *smell*, *sight*, and *hearing*.

Invertebrata:

(i) Worms without appendages (earthworms, round worms, etc.), and the leeches (*jalūka*), Annelida (*apādika*), and those with unsegmented lateral appendages (*nūpuraka*), the joint-legged arthropods (*gandupāda*), the top-shaped molluscs (*sankha*) and the Helicoid gastropods (*sambuka*), the bivalve molluscs such as pearl-oysters and mussels (*sūktika*) are put under the first group.
(ii) The ants (*pipīlika*) and the Formicid red ants (*rôhinīka*), the bugs and fleas (*upāchika*, *kunthu* and *tuburuka*), the weevils and lice (*trapusabija* and *karapāsāsthika*), the centipedes and spring-tails (*satapādi* and *utpātaka*), the plant-lice (*trinapatra*), the white-ants or termites (*kāshtahāraka*) are among those of the second group.
(iii) The bees, wasps and hornets (*bhramara*, *varata* and *sāranga*), the flies, gnats, gad-flies, and mosquitoes (*makshika*, *puttika*, *dansa*, and *mashaka*), the scorpions and spiders (*vrischika* and *nandyāvarta*), the butterflies and moths (*kīta*), the grass-hoppers and locusts (*patanga*) are amongst those of the third group.

Vertebrata:

(iv) The fish (*matsya*), the oviparous, limbed amphibians and reptiles (*bhujanga*), the oviparous apodal caecilians and reptiles (*uraga*), the birds (*pakshi*), and the quadrupeds (*chatuspāda* and *tiryakyôni*), and the biped or man (*dvipāda*) are among those of the fourth group.

The fourth group is sub-divided according to the mode of reproduction as follows: (1) *andaja* (pisces, Batrachia and Reptilia), (2) *jarāyuja* (mammals born with non-deciduous placenta), (3) *pôtaja* (mammals with deciduous placenta).

1. *Andaja* includes *sarpa* (serpents), *godha* (giant lizard-like monitor, etc.), *krikalāsa* (chameleon), *grihagôlika* (house lizard), *matsya* (fish), *kūrma* (tortoise and turtle), *nakra* (crocodile), *simsumāra* (porpoise or dolphin), and the *lômapaksha pakshi* (birds with feathers).

2. *Jarāyuja* includes man, ape, cattle, horse, camel, deer, hog, lion, tiger, bear, dog, and cat.

3. *Potaja* includes elephants, insectivores, hare, squirrel, mongoose, mice, and bats.

Knowledge of animal life in India amongst the Vedic Indians appears to have been comprehensive and widespread, judging from references to over 250 species of animals in the Rig, Yajur, and Atharva Vedas spread over the more important classes of the animal kingdom, particularly those of the phylum Vertebrata. A broad classification of animals based on their habits, such as *vāyavya* (living on air), *āranya* (wild), and *grāmya* (tame or domestic), seems to have been in vogue. Amongst the Invertebrates, the relatively fewer references are to the terrestrial Insects, though a few marine organisms like pearl-shells and the chank or *sankha* find a mention in the Vedic texts, which indicates that the Vedic civilization came into very little contact with maritime states and civilizations. Amongst the Vertebrata, by far the most numerous references are to the mammals and birds, though reptiles, amphibians, and fish find a place in the repertory of knowledge in the Vedic period.

The herbivorous ruminant and non-ruminant ungulates, and the elephant (*gaja* or *mrigahasti*), the ape (*kapi*, *kimpurusha*, *purusha mriga*), and the flying fox (*manthāvala*), the graminivorous or omnivorous Rodents, [hare (*sasa*), mouse (*mūshika*), rat (*ākhu*) and mole], and the carnivorous lion (*pītva* or *simha*), tiger (*vyāghra*, *sārdūla*), panther (*dvipin*), polecat and cat (*vrisha damsa*), hyena (*sāla-vrika*), wolf (*vrika*), jackal (*srigāla*), and dog (*svāna*, *kukura*), the ichneumon or mongoose (*nakula*), and the omnivorous bear (*ṛksha*), and the fabulous eight-legged beast or bird of the snowy regions referred to as *Sarabha*, and the dolphin (*makara*) amongst the aquatic inhabitants appear to be the mammals known in the Vedic age. There is also reference to the capture of lions in pitfalls (*paripad*). The bat (*jatu*) seems to have been treated separately, neither as a beast nor as a bird. We shall have occasion to revert to the herbivorous class of animals in greater detail further on.

A great variety of birds finds mention in the Vedic texts: the carrion-eating vulture (*gridhra*), the hunting eagle (*syēna*[1] or *suparna*), the falcon (*kshipra-syêna*) and other birds of prey, the carnivorous night-prowler owl (*ulūka*), the omnivorous crow (*vāyasa*, *lôpa* or *smasara śakunī*), the graminivorous pigeon (*kapôta*), and sparrow (*kalavinka*), the insectivorous cock (*kukkuta*), Cuckoo (referred to under a variety of names such as *kôka*, *kôkila*, *chakravāka* ?, *pika*), Curlew or snipe (*krauncha*), Quail (*laba*), partridge (or lapwing ?) (*tittiri*), peacock (*mayūra*), thrush (*rôpanaka*), woodpecker (*cāsha*), wagtail and the Cattle Egret (*gô-shadi*), the smaller honey-sucking or flower-visiting sunbird (*palanga* or *sakunta*), the aquatic group of birds, goose or duck (*chakravāka*), swan (*ati* or *hamsa*), diver (*madgu*), pelican (*plava*), crane (*bālaka*), and heron (*kanka*). Amongst the birds mentioned as being capable of separating milk from a mixture of milk and water are the eagle (*suparna*), the curlew (*krauncha*), and the swan or goose (*hamsa*). The last named is said to be capable of separating *soma* from a mixture of it with water.

---

[1] The sacrificial altar in the Asvamêdkayāga sites discovered near Dehra Dun is said to have the shape of a *syêna* in the act of flying with outspread wings (*vide* Ramachandran, T. N., in *A.I.R. Selections*, II, No. 2. pp. 46-48, 1946.

Amongst the reptiles, the snakes were very well known, each by its own special features of coloration, structure, or habits. The goat-eating python (*ajagara*), the boa-constrictor (*asita* or *vāhasa*), the crawler (*ahi* or *sarisripa*), the red coloured *lohitahi*, the speckle-necked *kalmasagrīva*, the cross-striped *tiraska-rāji*, the valuable-skinned *prdāku*, the viper (*svaja*) which is said to be attacked and killed by the deer or gazelle (*harina*) constitute the serpent tribes known to Vedic Indians. Great importance was attached to the study of serpents (*sarpa vidya*). The chameleon (*krikalasa*) and the house-lizard (*kundranāci*, *kumbhīnasa*), amongst the smaller land reptiles, the crocodile (*nakra*, also known as *ajagara*), the alligator (*simsumāra*), and the tortoise (*kacchapa* or *kūrma*) amongst the aquatic reptiles appear to be well known.

The only amphibian *sensu stricto* known was the frog (*mandūka* or *varshā-bhū*), which is supposed to have cooling properties and to call in the rains. The *mandūka* amongst the amphibians and the *tittiri* amongst the birds appear to have been used to designate two of the Upanishads, the *Māndūkyôpanishad* and the *Taittiriyôpanishad*.

It is curious that although a few references to fish and fishermen are found in the Vedic texts, they refer to a later period in Vedic age rather than the earlier. Angling of fish by hooks and the drying of fish and its sale appear to have been prevalent. The terms *purikāya*, *jasu*, *matsya*, and *sakula* appear to refer to some genera of fish, and the terms *kaivarta*, *dāsa*, *dhaivra*, and *saushkala* to fishermen or their profession and trade.

Amongst the Invertebrates the class Insecta is more frequently alluded to than the Crustacea and the Arachnida. The crab (*karkata* or *udra*) in the former, the spider (*ūrna nābhi*) and the scorpion (*vrischika* or *ajakava*) in the latter appear to have been most commonly noticed. The misleading general term 'worm' appears to have been applied to a varied assortment of earthworms, round worms, millipedes and centipedes, and grubs of insects, referred to under the terms *krimi*, *adrishta*, *alāndu*, *avaskava*, *kaskasa*, *kīta*, *kapana*, *nilangu*, etc. The caterpillar or worm-like larval forms of insects were probably the *trina jalayūka*, and any crawling worm-like form was also referred to as *tsaru*. Among Insects, the biting, the piercing or stinging, the boring, and the cutting forms seem to have been recognised. *Alapāsayu* and *patanga* were the generic terms for insects, the *prakankata* and *plusi* being the noxious ones. The locust (*salabha*), the bee (*pushkarasada*, *arangāra*, *sāra*, *bhringa*, *madhukrit*), the cochineal (*indragopa*), the termite (*upajihwaka*) which builds the ant hill (*vapa*, *valmīka*), the ants which eat the flesh of the dead (*pipīla* and *pipīlika*), and the grain-destroying (*jabhya*) and boring (*tarda*) beetles seem to have been distinguished, as also the different kinds of flies. The unwelcome and annoying house-fly termed *makshi* or *ādmasad*, the small biting fly or gadfly (*damsa*), the large biting fly (*mashaka*) which is said to be capable of biting even the thick-skinned elephant, the stinging wasp or other similar insects (*sūchika*), and the sky-illuminating fire-fly (*khadyôta*) are referred to in a number of places in the Vedic texts. The flies, mosquitoes, lice, and bugs are classed generally amongst the sweat-born (*svêdaja*) in *Mānava Dharma Sāstra*. A theory of spread of diseases by an unseen (*adrishta*), probably microscopic, worm (*krimi*) seems also to have been prevalent.

The horse, the cow, the sheep and goats, and man, collectively termed *pasu*, have received frequent mention in the Vedic texts.

The cattle, more particularly the bull, the cow, and the ox, and their calves, have been treated in great detail as may be seen from the innumerable terms used to differentiate them at various ages and conditions. Thus, the oxen employed for drawing carts were *anadvaha*, the bull (*usra*, *rishabha*, *gavaya*, *gaura*) separated from the cows was *maryaka*, the castrated ox was *nirasta* (applied to the castrated horse as well), the cow ceased to give milk was *dhênushtari*, and the cattle having a spleen-shaped mark branded on the ear were *plihakarna*, the young cow which has calved only once was *grishti*, the cow desiring the bull was *vasita*, the cow that miscarried was *vehat*, and the barren cow was *vasā*. Similarly, the calves of various ages were distinguished, e.g. the new-born calf (*ātmada*), the suckling calf (*dhāruna*), the 18-month old calf (*tryavi*), the 3-year old *trivatsa*, the 4-year old *turyanti* or *turyavaha*, and the young calf *vatsa* intended to induce the cow to give milk. Milk (*kshira* or *pāyas*) played a large part in the economy of Vedic Indians. It was taken warm from the udder or made into *ôdana* with grain (*kshiraudana*). *Ajakshira* (goat's milk) is also mentioned.

The cow was the chief source of wealth of the Vedic Indians. Milk was drunk fresh or made into butter or curds, mixed with *soma* or cooked with grain. Cows were milked thrice a day and grazed thrice. The milking cows were in the *gosala* at night, others were in the open pasture, but in the heat of the day all were in the cattle-shed. Cows were also used for drawing carts.

A similar distinction of horses as in the cows above seems to have also been in vogue. The side horse (of the four horses yoked to the chariot) on the right or in front was *prasti-prastya*, the stalled horse not allowed to graze was *marya* or *pastyāvant*; even the wild ass (*parasvant*) was distinguished from the domesticated *khara* or *gārdhaba*. The mule was known to be of mixed parentage (*Asvatara* ♂ or *asvatari* ♀, or *dwirêtas*) born of the horse and the ass or the mare and the ass. There are references to racing (*āji*) and a semi-circular race-course (*saptya* or *kastha*), and presumably the stalled horses were carefully maintained for the races or for being yoked to chariots which took part in the races. The race course had definite dimensions. Prizes were offered and eagerly competed for. The steeds used for the races were often washed and adorned.

Horses of various colours were known. A white horse with black ears mentioned in the *Atharva Veda* is said to be of special value.[1] Mares were preferred for drawing chariots, because of their swiftness and sureness, and also for drawing carts. Reins, halters, and whips were used to control horses.

The common and uncommon animals known in Vedic times were intelligently classified according to some peculiarities in structure or habits. Thus the dreaded beasts of the jungles were *mriga bhīma*, the animals of the forest were *āranya*, the small herbivores, sheep, goat, and ox, were *kshudra* and *anyatôdanta* (incisors in one jaw), and the larger whole-hoofed herbivorous horse and the ass the *eka-sapha* and *ubhayadanta*. There was even some reference to the embryonic membranes (*jarāyu*), the chorion as opposed to the amnion. The elephant was *hastin* by the use of its trunk for grasping things, and man was *ubhayadanta* (with incisors in both jaws) and *hastādana* by his habits of eating. The apes and monkeys which grasped their food by the mouth were *mukhādana*. It is evident that in Vedic times there were different kinds of stags (*ṛsya*), deer (*ruru*), antelopes (*êni*, *krishna*), Gazelle (*prshta*, *harina*), and also sheep (*avi*, *aja*) and goats (*chāga*), the buffalo (*mahisha*), the great bull (*mahoksha*), the rhinoceros (*khadga* or *vardhra nasa* in reference to its horn), the boar (*varāha* or *sūkara*), and the porcupine (*sva-vidh* or *salal*) whose quills were used for parting the hair and anointing the eyes.

There were innumerable economic uses for various animal products. The skins (*ajina*) of animals (goat, gazelle, antelope and tiger) used as clothing (*ajina-vsin*), and the furrier's trade were well known. Sheep's wool (*ūrnavati*) was used for making clothing and for filtering soma juice. The boar skin appears to have been used as material for making shoes or sandals (*upānah-sathapatha brahmaṇa*), and the rhinoceros hide as a covering for the chariot (*sāṅkhyāyana srauta sutra*). Flesh of both oxen and cows which were sacrificed was eaten always cooked, never raw. Hunting was also practised for recreation as well as for food and for the protection of cattle. The bow and arrow were used for hunting, but nets and pitfalls mostly for capture. Birds were caught in nets and snares. Pits were used for catching antelopes and lions. Elephants were captured with tame females. The boar was hunted with dogs in chase, and the buffalo was captured by ropes or lasso.[2] Fish were caught by netting, by hook, and by hands, by damming streams, and baiting with poisons.

---

[1] In a recent work entitled '*Asvasastra*' by Nakula (Edited by S. Gopalan, V. Swaminatha Atreya, and K. S. Subramania Sastri of the T. M. S. S. M. Library, Tanjore, S. India), the considerable knowledge developed in ancient India on horse-lore is referred to. A large mass of practical knowledge concerning the marks of good and bad horses, qualities of different breeds from various countries, the treatment of horse's ailments is ascribed partly to mythological and partly to historical authors.

[2] Owing probably to the military needs of the age, the knowledge of horses and elephants reached a high standard. There is thus a treatise on the elephant's health (*Hastyāyurveda*) of great antiquity. That a knowledge of animals in general was cultivated as a scientific pursuit is evident from the systematic treatment cows, dogs, goats, horses, and even cocks and turtles, receive in separate sections of Varāhamihira's *Brihat Samhita* (R. C. Mazumdar on 'Growth of *Scientific* spirit in Ancient India' in *Science and Culture, XVIII* pp. 463-472 (1953)).

Leather was used as material for making bow-string, sling, thong, rein, whip, bag, percussion instrument, and *bhastra* (bottle). The art of tanning hides appears to have been well known. The wetting of hides and its stretching over pegs are mentioned in the Vedic texts. Animal skins (*tvac* in Rig Veda) were also used in the process of extracting soma juice from the plant.

The sacrifice of a great variety of animals in *asvamêdha* (horse-sacrifice) and *purushamêdha* (human sacrifice) appears to have been common in Vedic times. Over 50 species of animals of all classes, big and small, are mentioned in the Vedic texts as being fit for such sacrifice. It is not clear whether all of them were eaten after the sacrificial ceremony. Amongst these are included serpents and other reptiles, frogs, birds, bats, carnivorous and herbivorous mammals including monkeys, even bees and other kinds of insects. Among human beings, the *hastipa* (elephant-keeper), the *kaivarta* (fisherman), the *dundubhi* (drum-beater), the *saushkala* (fish-catcher or angler) are classed as fit for sacrifice at *purushamêdha*.

III. Animal Life known in the period of Sangam Literature in the Tamil Country[1]

A great variety of mammals and birds, and a few species of reptiles and fish, and of arthropods are referred to in the Tamil Sangam literature of South India. Both the wild and the domesticated species are mentioned, not in special treatises dealing with their natural history, but only incidentally in the course of descriptive accounts in verse or prose of town and country, of crowns and kingdoms, and of wars and conquests. The sources of such references to animal life in the Tamil country are not only the well-known and ancient works like Tholkappiam, Silappadhikaram, etc., but also other forms of literature like Kurinjipāttu, Padittrupathu, Pattiṉapāllai, Kurunthôgai, Ainguru-nūru, Malạipadukadām, Kural, Nāladiar, Nānmaṇikkadigai, Nattrinai.

Amongst the mammals are mentioned the wild beasts including the lion and tiger, the wild cat, the bear and the boar, the porcupine, the elephant, the monkey, and the deer, the wild cow or bull, the jackal and the mongoose, the rabbit, squirrel and rat, and the domesticated ones including the goat, sheep and pig, the cow, bull and buffalo, the beasts of burden such as the ass, mule and horse, the elephant and the camel, and the dog and the bitch. The mythological *yāli* is also referred to.[2]

Amongst the reptiles, the cobra and the python, the tortoise and the turtle, the crocodile, and the lizard and the iguana find mention. The mythical or the freak five-headed cobra is also referred to.

---

[1] The Tamil Sangam literature is almost certainly spread over a long period, but there seems to be considerable difference of opinion in regard to its length. Prof. K. A. Nilakanta Sastri is of the view that it is spread over four centuries commencing with the 4th century A.D. On the contrary Sri A. Chidambaranār mentions at least thirteen sangams between 3000 B.C. and 1915 A.D. in his work, *Tamizh Changangalin Varalaru* (S. India Saiva Siddhanta Works Publishing Society Tinnevelly Ltd., Madras-1, 174 pp., 1948).

[2] The recent discoveries of examples of live animals in the sea of some of the weirdest species believed to have been extinct for millions of years must caution us against continued suspicion of oft-repeated statements of observed phenomena in so-called mythology.

The soaring birds, such as the kite (including the white-necked *garuda*) and the vulture, the domestic and jungle fowl, the crow, the sparrow and the pigeon, the peacock, parrot, koel, sky-lark and kingfisher, various kinds of owls, and the swan, crane and sea-fowl are mentioned. The rarity of the white crow and the white swan had probably evoked many descriptive chapters in Sangam literature. A more detailed account of the birds referred to in Tamil literature of the Sangam period is given below.

There are singularly few references to fish although some inferior kinds like *ayirai*, *iravu*, *irāl*, *suyal* and the shark (*suravu*) are mentioned. The only known crustacean is the crab.

Amongst the insects, the ant, bee and wasp, the dragon-fly and the winged Isoptera (*easal*), the white-ant or termite, the louse and the scorpion are referred to.

A few references to the descriptive accounts of animals in the Sangam Tamil period such as are given below will show that they are a mixture of observed facts, imagination, and poetic fancy, not a serious study in natural history.

In *Nedunāḷvādai* reference is made to the chill northern wind called *vādai* which affects animals in various ways, preventing cattle from grazing in the fields, and cows from suckling their calves, making monkeys shiver in cold, and birds to fall from trees.

The work called *Pattiṇappālai*, apart from its being a descriptive account of the ancient sea-coast city of Kaverippattinam, contains references to many domestic and wild animals known then. The temple in the city is compared to an elephant smeared with sacred ashes. Cowsheds, cows and buffaloes, deer, pigs, goats, and cocks, and an unidentifiable animal called *ôri* are referred to. The dog is described as frisking over bags of paddy, pepper, and other merchandise like the hill-goat, which jumps from rock to rock. An anchored ship in the harbour is compared to a tethered elephant in swinging motion. Amongst the many imports are horses from across the sea. King Karikāla Chôla in prison is compared to a caged tiger, and he is said to have escaped from prison like the male elephant caught in a pit which loosens the mud on the sides and fills in the pit to climb out. His success over the Pāṇdyās and Chêras in the battlefield of Koilvenni is compared to that of a lion cub in killing an elephant in a single pouncing charge.

In *Purānanooru*, and in the tenth song of *Pattuppāttu*, are mentioned several interesting facts of natural history. Donkeys are said to have been employed to plough the ground after the conquering king has razed to the ground the palaces and fortresses, and elephants let loose into the tanks and ponds to render them unusable by the vanquished. The male elephant wounded in battle is said to shun the company of the female, cease having ablutions in the tank, and to brood over its injuries and defeat, taking the form of a thunderous call. Elephants are stated to be so tame as to allow children to wash them. The abundance of tigers in the country and their encounter with elephants which often succeed in crushing them to death are referred to, as well as a tiger missing an elephant as its prey not caring to hunt a rat even when hungry. An indiscriminate collection of taxes by the king is compared to the wanton grazing of a corn-field by the tame elephant. A female deer which has lost its way in the hill-forests finds its way back to the herd by the peculiar call of the male, which is often taken advantage of by the tigers in the near-by caves. A hunting dog is said to be ferocious and fast enough to kill a herd of deer. The social habits of monkeys in sharing their finds in the forest are referred to, as for instance the male monkey which plucks a jak fruit inviting its mate to share it with him.

In another work called Kurunthôgai there are more references to the elephant, monkey, crow and other birds, bat, frog, crocodile, and fish. The male elephant of the desert region is said to peel the bark of a tree called *yam* (யாம் or யாமரம்) to squeeze the water out of it for the female to drink. The attack of a big elephant on a tiger and resting later in a garden, and the injured tiger waiting for an opportunity to catch the green-eyed red dog in the forest are referred to. A species of grass called the *korukkānthattai* is said to be a delicacy for elephants. The young of black monkeys playing with peacock eggs laid on firm ground in the forest is mentioned. The bereaved female monkey with young ones under its care would rather commit suicide by jumping into a mountain crevasse than see the young tormented by its relations. A black monkey with white face (probably the Langur) with its young ones shivers in the cold rainy season. The owner of a jack-fruit garden catches the fruit-stealing monkey with the help of a net spread under the tree. The call of the ubiquitous crow near a human dwelling is said to herald the arrival of guests, a well-known current belief in many parts of South India. Among other birds are mentioned the crane, the peacock, the parrot, the cock, and the dove. The crane known as *nārai* lying in wait for the fish (*āral*) is picturesquely referred to as the only witness to a promise made by a lover to his lady love. The crane known as *maraiyan* is said to eat the Indian gooseberry (*Phyllanthus emblica*) and to quench its thirst with water from mountain springs. It is a common experience that water of the worst kind tastes sweet if drunk after eating the gooseberry. The parrot is said to eat the neem fruit in the desert region, a habit common amongst crows. Cock-fighting was apparently a well-known sport in the Sangam period. The call of the dove in the forest is said to be that of a female while the male is away gathering food for the brood. There is frequent reference to the red-headed bird called *anril*, the male and female of which are inseparable and protest loudly with a cry when separated, which builds its beautiful golden-coloured nests on the ground.

The ominous cluck of the lizard (called *ôndi*), the structure and colour of the inflorescence of the sugar-cane while enclosed in its spathe resembling those of a gravid green tree-snake, the death of snakes caused by noise of thunder, the flying foxes or fruit-eating bats going in search of fruit trees at dusk, the call of the tree-frog (*thêrai*) resembling the sound of a drum called *thattai* beaten to scare away parrots from corn-fields, the danger of getting into water where the bow-legged male crocodile is known to live, the water-dog (probably the otter) eating the fish known as *valai*, which is said to devour a sweet mango dropping from a tree into the pond near the field in which it lives, and crabs scuttling away into their holes at the sight of a crane are just a few instances of close observation of the world of animal life. The persistent reference to the eight-legged mountain goat known as *varudai*, which is probably identical with the *sarabha* in Sanskrit literature, makes it probable, if not certain, that a freak goat such as we see exhibited in village fairs and festivals with extra legs hanging from its back is meant, not a mythical beast as is often supposed. In the Kurunthôgai the reference is to such a goat suckling its mother.

There are further detailed references to bird life in Tamil literature both in respect of their habits and their ecological distribution. In Thôlkāppiamarabu the class Aves is alluded to as creatures with five senses. The excellence of the swan (*vellānkurugu*), which is said to have a wide distribution in other countries in lotus tanks, its white colour, and its supposed capacity to separate milk from a mixture of it with water are referred to in a work called Chintamani. As in the case of the *anril*, there are innumerable references to a bird called *āsunam* in Tamil literature. The *chātaka*, *chakôra*, *chakravāka* and *kinnaramithunam* are also birds which find frequent reference both in Sanskrit and Tamil literature. The first-named, with its bright and shining eyes resembling the scintillating precious stone padmarāgam, lives on mountain tops and is believed to quench its thirst with rain drops. It is also referred to as *vānambadi* or *mêghappul* (skylark). In the lexicon called Pingalanighantu, the *chakôra* is referred to as *nilāmugippul* or the bird which drinks in the moonlight with its eyes. The beautiful golden-crested *chakravākam* or *nêmippul* is said to have the sky as its home and its eggs hatched by the heat of the sun's rays even before they reach the ground, so that the just-hatched birds take to the wing immediately. The flapping of the wings of *kinnaramithunam* is said to produce a musical sound akin to that produced by the stringed instrument known as the *yazh* or *yal*.

A great variety of fowls appears to have been recognised including the wild junglefowl (*kānakkôzhi*), the turkey (*vānkôzhi*), and the domestic fowl (*sêvarkôzhi*), and their greatest enemy is said to be the wild cat, known as *verugu*. Similarly among doves, the *manaivāzhpurā*, *mādappurā*, and *manipurā*. Their gregarious habit in seeking food, which has given rise to the aphorism *kapôtanyāyam*, their use as a homing bird to carry messages, their timid habits which make them fly away at loud noises, and their inability to fly against a strong breeze are all recorded. Three or four species or varieties of sparrow are recognised. Amongst these are the house-sparrow and probably the weaver-bird (*thookanānkuruvi*), which builds long pendulous nests from branches of trees and flies in groups in search of food. The external features and habits of the egret and the king-fisher have been accurately observed. The milk-white colour of the feathers of the egret (*kurugu* or *nārai*), its red mouth and webbed feet [?] resembling the roots of the palmyra palm, its cleverness in catching fish and crabs, the sharp needle-like golden-coloured beak of the king-fisher (*meenkothukuruvi*), and the rapid flapping motion of its wings in the act of watching the fish in water, resembling the motion of the hands of the mridangam-player, are picturesquely alluded to. The beauty of form and gait of the peacock, comparable only to that of a young maiden, and the resemblance of the crest on its head to the flower of a *vāgai* tree (*Pithecolobium saman*) are referred to. The first male progeny of the peacock is said to have a big and beautiful head-crest somewhat characteristic of the peacocks of the Kêkayā country where the poet Kamban in his Ramayana records the custom of crowning the first-born in Kêkayā. The *koel* or the *kuil*, stated to be only slightly different from the peacock [?] and to have a preference for the mango-tree, visits, like many other birds of its kind, such regions as have the *vasanta* (early summer) season on, and lays its eggs in the crow's nest where they are hatched by the crow until the fledgelings show by their voice their real identity.

Several varieties of parrots are recognised, some noted for imitative speech, some for carrying messages, and some others as ornamental pets carried on the hand or on the breast. They are said to prefer the fruit of the Neem tree. The differences among the owls both in their habitat and in their characteristic cries are recognised, like those which live in holes of trees or on hills. Tirukkural mentions the crow as the bird that will beat the owl in day-time. Vultures are mentioned as forest-dwellers, and one of them, *āndilappul*, is said to live near burial grounds and feed on the brain of the human carcass. The superstitious beliefs regarding the crow and its varieties, such as the sea-shore crow, the white-plumed and red-mouthed (*siruveṇkākkai*), the wave-crow (*alaikkākkai*) which is probably a sea-gull or petrel, and the forest crow (*kānakkākkai*) with plumes of the colours of *viruvākshi* flowers (probably a species of jasmine), are mentioned. The distinctions among the bats, which are presumably classed as birds, have been well drawn. The flying-fox or fruit bat (*vauvvāl* or *vāval*) which hangs head downwards from the *āmbal* tree with its wings resembling its leaves, the insectivorous bat (*turinjal*), which lives in dark places hanging from the roof of deserted houses and feeds on insects while on the wing, and the vampire bat, which is stated to suck the blood from the toe of a sleeping person without his being aware of it, are among such examples. Among the soaring birds which are said to fly very high and to build nests on high rocks among mountain tops are the kites (*parundu*, *poguval*, *garudan*, *sakuntam*) and the vultures (*kazhugu*). The long-lived *jatāyu* and *sampāthi* mentioned in the Rāmayana are probably the *garuda*-kind of kites.

The eight-legged *simbul* or *eṇkālparavi* or *sarabham*, which is so strong as to strike terror among lions, the *yanaiirunji* which is capable of attacking the elephant and eating its brain, the big bird *chari* which is mentioned in the Mahābhārata as being capable of moving rocks (like the huge birds referred to in the Arabian Nights as Roc) are presumably to be classed among the legendary animals. The *vicchuli*, which is probably a soaring kite, is said to have the power of sighting its prey from a great height and of swooping down on it at great speed, picking it up in its sharp beak, and of soaring back to the sky.

Some more or less accurate knowledge of the ecology of the various elements of the fauna seems to have existed even in the earliest known Sangam literature.

Thus the ecological divisions are (1) *mullai* (woodlands), (2) *kurinji* (hilly regions), (3) *marudam* (riverine tracts), (4) *neydal* (seacoast), and (5) *pālai* (dry or desert tracts), each with its own characteristic fauna. The deer, hare, and wild goat which constitute the food of the people are characteristic of (1); the elephant, bear, boar, parrot, peacock, and other birds of (2), where hunting and extermination of locusts are the chief occupations of people; cattle, sheep, goat, rodents, ducks, waterfowl, koel, etc. of (3), where bull-racing is a favourite sport; the fish, shark, alligator, sea-gull, and cattle of (4), and the elephant, tiger, wild dog, eagle, kite, and pigeon of (5)[1].

IV. ANIMAL LIFE IN THE SULTANATE AND THE MOGHUL PERIOD

Although modern Zoology in India may be said to date with the advent of the British into this country, it has its roots in the recorded knowledge left in various authentic works by the Moghul emperors themselves or by their distinguished contemporaries in their courts. The memoirs of Babur and of Jehangir and the *Ain-e-Akbari* of Abul Fazl, and various other Islamic works have been the main sources of such knowledge[2]. The Emperors themselves were great sportsmen and distinguished naturalists of their times, and their interest in the fauna of the country was so great that they could hardly allow their knowledge of it to remain unrecorded. To this knowledge was added the recorded experience of foreign visitors during the Moghul period.

The animals known during this period belong mostly to the phylum Vertebrata, more particularly to the mammals which were wild and hunted or domesticated and used for defence, ceremonial purposes, and amusements. Elephants, horses, hounds, dogs, cheetahs, lynxes, falcons, hawks, cocks, parrots were some of the animals which were most intimately connected with the sports and pastimes of princes or their wars. During the period between the early 13th century and the middle of the 16th century, there is abundant evidence of the civilized way of life in which animals played a great part. Firuz Tughlak is stated to have maintained a Shikar Department which was considered to be one of the most important departments of his Government. Sher Shah is said to have maintained in his Kingdom 5,000 elephants and 3,400 horses, the latter particularly for postal communications. There were many officials to supervise the royal stables. In Muhammad Tughlak's time 2,500 oxen, 2,000 sheep and various other animals and birds are said to have been slaughtered daily to supply the royal kitchen. There were 10,000 followers who rode on horse-back, each carrying a trained falcon for hawking. Horse-racing and dog-racing were so popular that a regular literature is said to have sprung up on the study of the habits and the methods of training horses and dogs. Pedigree horses were maintained, and the game of polo was played substantially as it is at the present day. Horses were employed for conveyance and pleasure-riding in addition to racing. Elephants are said to have been trained for carrying heavy loads, for riding, and for use on ceremonial occasions.[1] They were found commonly as far afield as U.P. and Orissa, elephant-catching was a profession. The idea of game preserves was probably derived from an old Persian tradition. Great walled enclosures were built to preserve wild and domestic animals. A State preserve near Delhi 12 *krohs* (24 miles) in extent is stated to have been maintained. Rhinoceros and lions, deer and nilgai seem to have roamed at the foot of the hills of the Punjab. The lion was, however, the prerogative of the monarch to hunt whenever one was spotted. Fishing was as popular a sport as pigeon-flying or cock-fighting. Alauddin Khilji maintained a pigeon house, and Akbar was passionately fond of pigeon flying, a pastime which is still so popular among the muslims all over India, particularly in the North. The parrot was a familiar pet in royal palaces, and in the households of the opulent as well as the poor. Monkeys were also kept as domestic pets. Dogs were trained for the chase as well as for guarding houses.

---

[1] The author is indebted to Prof. K. A. Nilakanta Sastri for placing at his disposal some manuscript notes made by various Tamil scholars in S. India, and to the notes of Sri K. R. Venkataraman, Retd. D. P. I. and Records Officer, Pudukkottai for the ecological classification.

[2] Ali, Sālim A.—The Moghul Emperors of India as Naturalists and Sportsmen. *JBNHS*, Part I, **31** : 833-861 (1927), Part II **32** : 34-63, Part III **32** : 264-273 (1927-28).

Where animals were so largely in use in the four centuries covered by this account, their leather could not have been in less demand. Saddle and bridle for horses, scabbards of swords, covers of books, shoes, bags for packing sugar as in Bengal, mats in red and blue inlaid with figures of birds and beasts as in Gujarat, which evoked the praise of Marco Polo, were all made of leathers of various kinds. Skins of cattle (ox and buffalo), goats, rhinoceros, etc. were dressed and exported in shiploads to Arabia and other countries.

A fairly accurate and dependable knowledge of the fauna of the country during the rule of the Moghul dynasty could be gained from the memoirs mentioned above. There are references to wild animals, such as the elephant, lion and tiger, leopard, rhinoceros, cheetah, lynx and caracal, wild cat and dog, wolf, hyena and jackal, bear and otter, the flying fox and the flying squirrel, the hare and the squirrel, and the lemur, the monkey, and the ape. Babur had distinguished the white-faced Rhesus monkey from the black-faced long-tailed Langur. He knew that the Gibbon was not indigenous, that the flying fox was the great bat, that the elephant was peculiar to Hindustan and occurred in a wild state as far as Kalpi on the right bank of the Yamuna river in the Jalaun District of Uttar Pradesh, and that the rhinoceros was distributed all over north-west India in the jungles of Peshawar and Sind, and on the banks of the Daryu River (Gogra). He is said to have hunted a rhino in the Indus Valley in 1519. Abul Fazl has recorded the tailless ape (*ban-manush* or *jal manus* or orang-utan) as having been brought to Akbar from Bengal. He has mentioned the lion and the tiger as being numerous, man-eating tigers having been recorded from Ajmer in 1572 and at Agra in 1609, and the milk of a tigress as being a panacea for eye-troubles, the snow leopard of Kashmir and the lynx and the caracal as used for hunting hare, fox, and blackbuck, the hunting leopard or cheetah which was kept in large numbers by the Moghul emperors for hunting, and the civet cats which yielded the perfume of which they were so fond as mentioned in Abul Fazl's memoir. The animal referred to as *sardol* or *sardoola*, 'smaller than a dog, but preys upon lions and other wild beasts' is not exactly referable to any identifiable beast of prey.[1] The Kheddah operation of capturing wild elephants in the Gond country of Mandla in Madhya Pradesh seems to have prevailed in much the same form as it is practised today. Abul Fazl mentions breast-plates and shields made of the skin of the rhinoceros, and finger-guards for bow-strings etc. from its horn.[2]

---

[1] There are painted representations of horses, elephants and camels in procession on the ceiling of the Virupakshi temple in Hampi dating back to the 14th century A.D. One of the panels shows the sage Vidyaranya borne along in a palanquin preceded by Purohits and followed by a camel. Another shows the Emperor Krishna Devaraya in state procession drawn by horses and elephants. A panel showing puranic heroes portrays birds and other animals, Hanuman and the Yāli, some of them in a conventional manner. (R. Chinnathambi's article in 'The Hindu' of Sunday, March 22, 1953 on 'Paintings in the Virupakshi Temple in Hampi'.)

Jehangir's profound knowledge of animal life seems to have been born of a passion to observe and record the habits of animals. He referred to the suckling by a goat of a baby langur the mother of which was shot. He knew accurately the difference between the rare Lemurs (slender loris or *thevangu*), of which he had seen an example brought to him from Goa, and the Simians and anthropoid apes, and their habit of feeding on milk and plantains. The lion must have been numerous in his and his father's times for him to have recorded a lion hunt by Akbar, to have shot one himself near Malwa in 1617, and to have permitted Sir Thomas Roe to kill one in his camp near Mandu in Madhya Bharat. The elephant appears to have been found in a wild state as far as the Panchmahal District in Bombay. Jehangir has recorded the 'water-dog', probably the otter, in the Jhelum River, the breeding of cheetahs in captivity, and several cases of albinism in a wide range of mammals and birds, including the cheetah, blackbuck, flying squirrel, hawk, and quail.

The knowledge of the ungulate and bird-fauna of India as recorded in the memoirs of Babur, Abul Fazl, and Jehangir in the Moghul period was no less profound. The Yak, the wild buffalo, the various kinds of goats, and the Nilgai, the antelope, the hog deer, the wild boar, the dolphin or porpoise, a large variety of game and other birds, common in the garden and near human habitations and in the jungles near about, all find a mention in these records. The Moghul emperors were as a rule fond of hunting, and spared no personal exertion in the pursuit of sport. They appraised their game by weight, and not by the dimensions of the body or the horn as is done in modern times.

Babur had known the wild buffalo (*Bos bubalus*) to be larger in size and more ferocious and destructive than the common buffalo. He described the *kālā hiran* of Hindustan or the Indian antelope or blackbuck (*Antilope cervicapra*), and had noted the occurrence of the dolphin (*Platanista gangetica*) in all the rivers of Hindustan and described its habits accurately by calling it the water hog (*khūk-e-ābi*).

---

[1] [It may be the wild dog (*Cuon alpinus*) called *dhole* in central India. EDS.]

[2] Timur is recorded to have hunted and killed many rhinoceros on the frontiers of Kashmir in 1398, and a rhino is reported to have been sent from India to King Emmanuel of Portugal as a present in 1513, who in turn presented it to the Pope. ('The Return of the Rhinoceros ' by B. V. Ramanujulu in ' The Hindu ' August 9, 1953).

The wild ass of Sind (*Equus hemionus khur*) was hunted by Akbar (April 1571) on the banks of the Sutlej River. Jehangir has recorded its flesh to be *halal* and good eating, as also that of the mountain goat (*Capra falconeri*). Abul Fazl has recorded the occurrence of the Yak in the mountainous parts of Kumaon where it corresponds to the domestic cow. Though luxurious growth of wool on the limbs had been noticed by Jehangir, its close resemblance to a buffalo in form and appearance was not missed. Abul Fazl described how a wild buffalo was hunted with the help of a tame cow on heat by being lassoed or held in nooses.

There is good evidence of breeding experiments and hybridisation of goats and deer having been undertaken during Moghul times. Jehangir carried out such experiments between the Ibex and the Barbary goat, and Abul Fazl has mentioned the maintenance of regular deer studs to breed blackbuck to be trained as decoys for catching and hunting the wild antelope. The hunting of the hog deer (*Axis porcinus*) and the wild boar (*Sus scrofa cristatus*) was a sport in the district of Tutta in Sind. Abul Fazl has referred in his *Fauna of Hindustan* to a species of deer larger than a fox with a rough coat of hair and two protuberance-like tusks, but without horns, occurring in the northern mountains and Kumaon. This is probably the musk deer of whose flesh Jehangir had spoken as being tasteless and inferior. The female of this species is noted to be without the musk bag, which gives out the characteristic odour only when it has been dry for a few days. More modern opinion about the flesh of the musk deer as expressed by European taste is that it is free from the flavour of musk and very good to eat. The wild boar which is still plentiful in Sind and a serious pest to cultivation afforded a very popular hunt. England's ambassador to India (Sir Thomas Roe) has recorded the receipt of a gift of a wild boar for his table but with the unusual request for the return of the extraordinary-sized tusk.

Among the birds described or noticed during the Moghul period were the common crow (*Corvus splendens*), the sparrow, the green magpie, the racket-tailed drongo, the scarlet minivet, the dipper, the starling, the myna, the lark, the cuckoo, and the koel near human habitations, apart from the parakeets, eagle, kite, falcon, fowl, pheasant, quail, partridge, green pigeon, etc. of the jungles, and the aquatic birds crane, stork, spotbilled duck, ibis, and the large bustard, florican, etc. Sparrows were probably such a pest that their numbers had to be thinned out by pellet bows fitted with bow strings. Akbar seems to have amused himself with the training of frogs to catch sparrows. Jehangir has recorded the habits of the pied crested cuckoo (*papiha*) and the koel, the former laying its eggs in the nest of babbler which brings up its young, as the latter does in that of a crow. Akbar is said to have maintained 20,000 carrier pigeons. The Italian traveller, Manucci, has described how the nobles in the court of Shah Jehan bred pigeons to carry messages, or to take part in pigeon-fighting as a sport. The peacock does not appear to have been favoured for the table by Babur, though classical works allude to its appreciation at banquets.

Amongst the reptiles and amphibians the marsh crocodile, the gharial, the python, the cobra, and frogs find mention, while among the fishes the hilsa and rohu are recorded. A few insects like the bee, and the silkworm, the gnats, fleas, flies, and lice are also referred to.

Babur referred to the Marsh Crocodile (*Crocodilus palustris*) as the *sherabi* or 'Water Lion' or *siyah sar* (= black head in Persian) (*Crocodilus porosus*), as occurring in the rivers of Hindustan, and to the gharial (*Gavialis gangeticus*) as an inhabitant of the Gogra (Sarju River) ready to carry off unwary bathers. Jehangir has recorded the shooting of a crocodile in Dhar State, the swallowing of hares, hog deer, etc. by a python near Aligarh, and of a cobra by a king Cobra (*Naja hannah*). Manucci, the Pepys of Moghul India, has recorded the punishment of corrupt people by the bite of poisonous snakes in the court of Shah Jehan, while Prince Shah Shuja, Shah Jehan's son, has recorded the extraordinary migration of cobras from fields near Rajmahal in Bengal.

Babur has closely observed the skipping of frogs (*Rana cyanophlictis*) along the water surface. The habit of bull-frogs in swallowing birds including chickens and even snakes, along with the training of frogs to catch sparrows, are mentioned in Abul Fazl's memoirs. The same author has recorded the fishing of *palla* (hilsa of Bengal) near Tutta in Sind in the months of February and March and referred to its unrivalled, fine, and exquisite flavour. Jehangir was interested in fishing as in the hunt. He thought rohu was the best fish of Hindustan and recorded an instance of blindness in fish in one of the streams (Andha Nag) of Kashmir.

The silk industry and silkworms find a mention in Abul Fazl's memoirs. The silkworms seem to have been abundant in Kumaon and Kashmir, and so were mulberry trees the leaves of which constituted their main food. The eggs were, however, imported from Gilgit and Tibet.

According to Abul Fazl the Kashmir valley appears to have been infected with gnats, flies, fleas, and lice. Jehangir has recorded the visit of black bees to the flowers of the lotus and the kumuda.

The maintenance of various animals (goats, rams, cocks, quails, stags, antelopes) for fights to amuse people, and of hospitals or pinjrapoles for the care of these and other animals seems to have been common in the Moghul era. The traveller, Pietro della Valle, had seen during Jehangir's reign a pinjrapole at Cambay for many kinds of birds (cock, pigeon, peacock, duck), mice, etc., and the traveller, Thevenot, had known a hospital for birds in Ahmedabad during Aurangazeb's time, apart from hospitals for camels, ox, horse, and other animals. He also recorded that in Dehly (Delhi) wealthy individuals and kings maintained hawks, camels, dromedaries, mules, asses, elephants, elks, rhinoceroses, and buffaloes. The last-named were described to have been of such size and power that they were unafraid of lions. Some of the home-bred camels seemed to have been capable of carrying considerable weights, and Jehangir has recorded an instance of one such having carried on its back a weight of 42 maunds (1,460 lb.). Thevenot has described a curious method of capturing water fowl during Aurangazeb's time by men swimming upright in water with their heads completely hidden in a many-holed pot covered by birds' feathers to cheat the ducks and water fowls, and cunningly catching hold of their feet under water and pulling them down into it to drown them. Equally strange was the method of catching sandgrouse and other similar game birds recorded by Jehangir in which the birds concerned were rendered powerless to fly by a murmuring sound produced by some Kashmiri bird-catchers.

V. ANIMAL LIFE IN INDIA IN THE POST-MOGHUL PERIOD UP TO MODERN TIMES (17TH CENTURY TO MIDDLE OF 20TH CENTURY)

Although there are many stray references to Indian animals in the chronicles of foreign travellers, and evidences of trade and traffic in animals (ivory, apes, and peacocks) between eastern Europe and India, the earliest published works based on a study of indigenous animals were from the pen of foreign residents and sojourners in India. Robert Knox's 'Historical Relation of the Island of Ceylon in the East Indies' (1681), Koenig's account of the white-ants of India 1779), Patrick Russell's accounts of the Indian Serpents of the Coromandel Coast (1796) and of the Fishes of the Visakhapatnam Coast (1802), Hamilton-Buchanan's account of the Fishes of the Ganges and its branches (1822), and Gray's 'Illustrations of Indian Zoology' (1830-32), featuring a large number of Vertebrates of the Indian region, are of this nature.[1] This tradition of detailed recording of observed natural phenomena relating to the fauna of India has been more or less continuous during the three centuries following the disruption of the Moghul dynasty, but much of the organised study of animal life which struck deep root in the country we owe to the British residents in India some of whom were keen sportsmen-naturalists, but more particularly to the learned societies, like the Asiatic Society of Bengal in Calcutta, and the Bombay Natural History Society in Bombay, which they helped to establish with the influence they wielded as the representatives of the British ruling class.[2] The accumulation of permanently preservable parts of animals, such as bones, skins, and feathers, for exhibition by the members of the former Society led to the founding of the Oriental Museum of the Asiatic Society (1814), which led later on (1866) to the establishment of a public museum under Government auspices in Calcutta, but the '*ahimsa*' or non-violence attitude of Sir William Jones, the Founder-President of the former Society, who discouraged the killing of animals to gain natural knowledge proved a set-back to the study of animal life in India for sometime (till 1828). The natural curiosity of interested observers to learn more and more of the structure and habits of animals could not, however, be curbed for long. From 1829 onwards there was a stream of contributions dealing with animal structure, particularly of those animals whose anatomical parts could be preserved in the dry state, as for instance the bones, skins, feathers, and scales in mammals, birds, reptiles, amphibia, and fish, and the shells, internal or external, of cuttle-fish, snails, mussels, cockles, clams, and oysters.

---

[1] Gravely, F. H.—*Proc. Asiatic Soc. Bengal* (N. S.) XVII, p. cxxxii (1921).

[2] *Centenary Review of the Asiatic Society of Bengal* (1784 to 1883). Calcutta (1885).

The records of observed habits of animals in their natural environment led to considerable curiosity in others who, if they could not satisfy their curiosity to observe them in their natural haunts, in the forests, and on the mountains, could at least see them alive confined in cages. This natural curiosity led to the establishment of zoological gardens, or 'Zoos' in short, within the municipal limits of towns and cities. The initial stimulus for the establishment of such zoos came also from the Asiatic Society as early as 1842, and probably the first zoo in India was opened in Calcutta in 1876 with the object of 'developing and displaying the zoological wealth of the country and of facilitating acclimatisation, domestication, and breeding of animals, and improving the indigenous breed of cattle and farm-stock'. This was followed by other zoos in the country in Madras, Mysore, Trivandrum, Bombay, etc. The maintenance of wild life in zoos and in sanctuaries to be mentioned below has helped the study of the natural longevity of various species of animals on a more or less scientific basis, confirming or rejecting existing beliefs on the subject, recorded or otherwise. The exhibition of dead animals in museums, stuffed in their skins, and in attitudes often grotesque and unnatural though based on the observations of sportsmen and naturalists, did not satisfy the natural curiosity of people to learn something of the environment in which the animals lived. This gave a new stimulus to museum technique though borrowed from the West, particularly the United States of America, where museum technicians excelled in the art of mounting the elements of their fauna in as lifelike a manner as seen in nature against a background of the proper environment. This environment was cleverly painted on walls in vivid colours with the illusion of depth and in settings made of natural materials obtained from the environment, or their substitutes artificially made to resemble them, the whole scenery suitably illuminated with electricity to resemble the lights and shades prevailing in the natural environment. A pioneer in this method of exhibition in India has been the Bombay Natural History Society in the Prince of Wales Museum, Bombay, which is, slowly though gradually, being adopted by other museums in the country.

A similar renaissance in the organisation and exhibition of living animals in zoological gardens is taking on the form of total elimination of all bars to the freedom of movement and of life of animals kept in them, such as has been introduced in the founding of national parks elsewhere in Europe, Africa, and America, which serves a double purpose, namely of protecting animals from wanton destruction by shikaris and trophy-hunters and of educating the public in the study of animal behaviour in their own natural and native environment. A chain of game sanctuaries for wild life (fish as well as birds, reptiles, and mammals) is being established all over this country. The protection to the lion[1] and the rhinoceros[2] which have been noticeably getting rarer in their natural haunts in India has been one of the first steps in governmental action to preserve the fauna peculiar to India.[3] A greater and more recent stimulus to this idea of wild life preservation has been the organisation under Government auspices of an Indian Board for Wild Life, to which is entrusted the task of creating interest in the people in the wild life resources of the country, both in their economic and philosophical aspects, and of sustaining it by continuous educative propaganda and publicity.

---

[1] The lion seems to have been progressively driven out west further and further from its original haunts in N. India extending up to W. Bengal and Bihar at the beginning of the 19th century to the Gir forest in Kathiawar (Saurashtra, now merged in Bombay State) at the present day. Lions had been recorded alive in Palamau in Bihar up to 1814, in Central India (Madhya Bharat) up to 1872, in Gujarat up to 1880, in Hariana (Pepsu) up to 1834, and even as far west as Kot Diji in Sind up to

Knowledge of the animals in the seas around India appears to have been confined, however, during the many centuries of Indian History to certain large-sized animals like the whales and the sharks, which were apparently brought to the notice of people living on the coast by the carcases of dead animals sometimes washed ashore. Even the ardour of British sportsmen and naturalists resident in India to extend the bounds of knowledge of animal life in the country lay dormant so far as the sea was concerned. The success of the British 'Challenger' Expedition in its cruise round the world, and the efforts of influential British biologists on the Council of the Asiatic Society of Bengal were some of the contributory causes to the inauguration of a marine survey in India in 1874. The interest of the naturalists of the Indian Museum had already been stimulated by the deep-sea investigations in 1872 conducted by Wood-Mason in the deep-sea off the Andaman Coast, and led later on to the appointment of a Surgeon-Naturalist to the Marine Survey of India. Deep-sea investigation was a complicated and costly task. It required a fairly large sea-worthy vessel and special equipment to capture sea animals at various depths. The building of the 'Investigator' for the Marine Survey and the procurement of equipment from the 'Challenger' which had completed its cruise in 1877 helped to organise the investigation of animal life in the Indian seas. Between 1884 and 1926, the year in which the 'Investigator' ceased to carry a naturalist on board, the fauna of the seas along the coasts of India, Burma, Ceylon, and as far afield as the Persian Gulf, and in depths down to 2,000 fathoms, around the oceanic islands of the Andamans and Nicobars, the Maldives and the Laccadives, was investigated. This survey revealed a great wealth of animal life, both Vertebrates and Invertebrates, of the most varied and weird kind, which was described and illustrated in special publications brought out by the authorities of the Indian Museum from 1898 onwards.

For the first time in India, the attention of the Indian students of zoology in the Madras and the Punjab universities, where the subject

---

1842 which is only about 20 miles east of Mohenjodaro. The introduction of East African lions into Gwalior late in the 19th century when the Indian Lion had almost become extinct proved so disastrous that they had to be exterminated soon after their introduction.

[2] To ensure the maximum possible protection to the Rhinoceros in Assam, which is the State emblem of the Assam Government because of its almost exclusive occurrence in that State, a 'Rhinoceros Preservation Bill' is being drafted by that Government.

[3] This protection has now been extended by the Board to 11 more species viz. the snow leopard, the clouded leopard, the cheetah, the wild ass, the Kashmir stag, the musk deer, the brow-antlered deer, the pygmy hog, the great Indian Bustard, the pinkheaded duck, and the whitewinged wood duck.

had been introduced for higher studies, was drawn to the far greater wealth of animal life in the sea than on land, most of which was unfamiliar except to those actively engaged in catching fish at sea for many generations, and of which there exists no recorded knowledge in history. The part played by museums of Natural History, of which there are only a few in number at present in this country, and by aquaria, which can be counted on the fingers of one hand, in disseminating an authentic knowledge of the infinite wealth of life in the sea is still so small that it will take many years of effort to attain a decent standard of public education in the subject of the unfamiliar aquatic world.

The pride of founding the first aquarium in India as early as 1909 goes to the Government Museum of Madras which arranged to exhibit, in specially built glass-faced cisterns with arrangements for constant circulation of water and air, some colourful sea-animals, particularly fish of certain types common on our Coast.[1] After nearly 33 years of existence on the Madras Marina Beach opposite the Presidency College, the aquarium was closed down in 1942 in the middle of the Second World War, and reopened to the public only recently in an attenuated form exhibiting a few small species of freshwater fish. The aquarium at Trivandrum maintained by the Marine Biology Department of the University of Travancore and the more modern one on the Marine Drive (Taraporevala Aquarium) at Bombay maintained under the auspices of Fisheries Department of Bombay continue to stimulate the curiosity of people in the forms of life which inhabit the sea.

No less important and vital contributions to our knowledge of the infinitely varied life, both in its grosser and in its minuter and cryptic forms, in the vast world of Invertebrates both on land and sea were made in the first half of the twentieth century. These were inevitably the result of scientific investigations undertaken in connection with agriculture, forestry, medicine, animal husbandry, and other applied biological sciences. Innumerable animals, acting as pests and vectors of diseases in plants, animals, and human beings, were discovered and described and controlled, among other means, by the employment of biological methods based on the mutual natural animosity of two or more species of animals. The discovery of the method of transmission of the malarial and plague parasites (?), which was made on Indian soil, led to appropriate efforts in the direction of controlling the actual vectors, namely the anopheline mosquitoes and the rats respectively, which carried the disease-causing parasites.

Although the elements of every group of the animal kingdom have their own environment to which they are adapted in every way, the competition for living space and food often compels them to extend their domain into neighbouring regions. The study of the geographical distribution of animals, on which many theories of the present and past configuration of continents and seas are based, has therefore been a subject of considerable importance. In so far as the Indian fauna is concerned, this study of geographical distribution of strictly indigenous and related species of animals has been greatly furthered by the publication of records of animal distribution maintained in the course of expeditions under official auspices during the British regime in India into the adjoining extra-territorial regions. The Yunnan Expeditions (1868 and 1875), the Persian Boundary Commission (1870-72), the Second Yarkand Commission (1873-74), the Dafla Expedition (1874-75), the Afghan Delimitation Commission (1885), the Afghan-Baluch Boundary Commission (1896), the Pamir Boundary Commission (1896), the Military Expedition to Lhasa in Tibet (1903-04), the Seistan-Arbitration Commission (1903-05), and the Abor Expedition (1911-12) have not only brought to light some rare and hitherto unknown groups of animals, but also the peculiarities of distribution of various animals of the Indian continent, and their excursions into adjoining geographically similar territories ignoring man-made political boundaries[1].

---

[1] The control of the Aquarium was later (1919) [transferred from the Government Museum to the Madras Fisheries Department.

VI. Fish and Fisheries in India

There are several references to the knowledge of fish and fisheries in India through the ages[2]. One of the earliest of them on the subject is to be found in the Susrūta Samhita (*ca.* 600 B.C.[3]) where a knowledge of the known marine and freshwater fishes of India and their habits in relation to their habitat, form, and motion is clearly indicated. It is found that in the Sanskrit names given to freshwater fishes of various kinds living in the larger rivers like the Sindhu and the Ganga (Indus and Ganges) there is some significance in reference to their structure or habits. Names like *prithuroman*, *sakula* or *sakalin*, *salkin*, *samvar* seem to have such significance, though terms like *matsya*, *meena*, *animisha*, *jalasaya* and *usha* may be applicable to any kind of fish in reference to their habits, and their places in the classification of the animal kingdom. In the age to which Susrūta's works (*ca.* 600 B.C.) and Kautilya's Arthasāstra (*ca.* 300 B.C.) refer, there seems to have been ample evidence of a more or less detailed observed knowledge of fish as a valued item of food and as providing an industry, as being aquatic and oviparous, and as capable of being classified in terms of their structure (scales and body plates, spines, barbels, colour and markings) or habits (in standing or flowing waters, swimming and sticking to substrata, etc.). The identification of the fish or fish-like aquatic mammals which find a mention in Asoka's pillar edict V, attempted by Hora (1950), appears to be quite plausible, and the fish referred to are the boneless or cartilaginous sharks and skates, the slippery eels, the death-feigning globe-fish, and the lumpy-bodied porpoise. Coins of the Pandyan Kingdom are stated to bear the fish symbol as the Chola and Chera coins bear other animal symbols like the tiger, bird etc. (*vide* Dandapany, T.S. in 'The Hindu', 14th March, 1957).

---

[1] 'Progress of Science in India during the past twenty five years'. Ind. Sci. Congress Association Silver Jubilee, 1938. Edited by B. Prashad.

[2] The Atharva Veda and the Satapatha Brāhmana are said to narrate a legend in which a fish saved a Manu from a deluge. Similar legends seem to exist in some of the earliest mythologies of the world (*vide* U. Venkata Krishna Rao in *Bhavan's Journal*, 3 (7) : 56-58, 1956).

[3] According to the agreed chronology at the Symposium of the National Institute of Sciences of India, the dates of Susrūta Samhita, Arthasāstra, and Chāraka Samhita 4th century B.C. have been advanced to 100 to 200 A.D.

The gradual development of fisheries in irrigation tanks in north and south India from the 5th century to the 16th century A.D. has been traced in several works. King Someswara's *Mānasôllōsa* of the 12th century is said to contain in a chapter entitled '*matsyavinoda*' a large mass of interesting facts relating to various types of fish and to the sport and pastime of angling as known in the preceding two centuries. These reveal a very detailed and accurate knowledge of the maintenance of tanks and ponds, and the culture and angling of various kinds of fish valued as food and game. Someswara's classification of fishes, specially of the kind used in sport, is based on their size and habitat, and the references to the rod, line, hook, and bait are also in relation to the nature of the waters fished, marine, estuarine, or riverine.

One of the more recent works on sporting fish in India and Burma (Macdonald, 1948)[1] contains a list of freshwater fishes very little different from those known to Someswara.

Fisheries is mentioned as one of the thriving industries in the Vijayanagar Empire[2].

The second World War, the Bengal famine of 1943 and the recommendations of the Famine Commission (1945) seem to have given a great fillip to the study of Fish and Fisheries in India although some attention had been bestowed on this subject for over a century previous. Panikkar (1956) has recently reviewed the progress of work in fish and fisheries in the country[3].

---

[1] Macdonald, A. St. J., *Circumventing the Masheer and other Sporting Fish in India and Burma* (Bombay, 1948).

[2] Mahalingam, T. V., *Economic Life in the Vijayanagar Empire.* (Madras 1953).

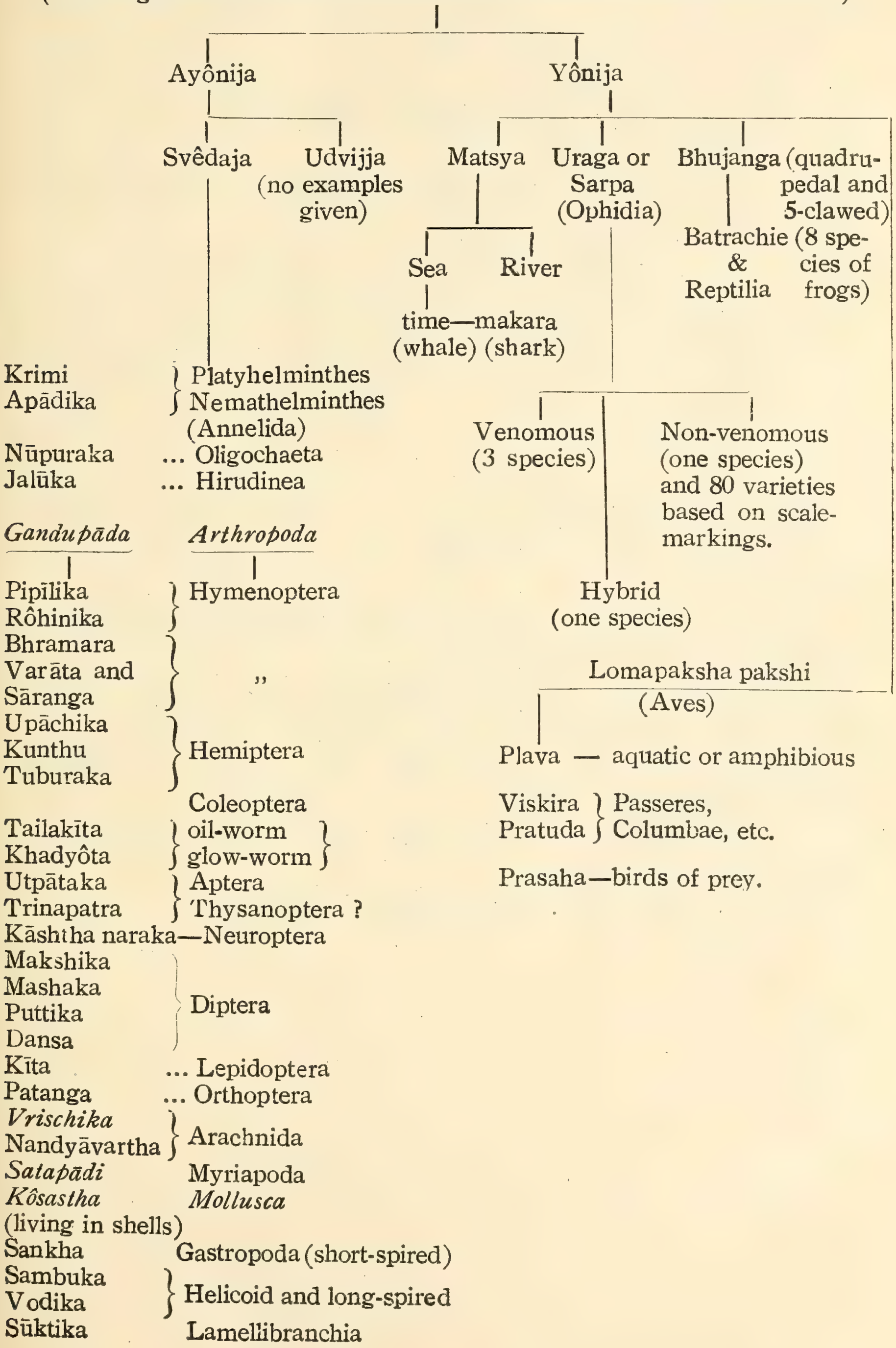
[3] Panikkar, N. K. (1956)—Progress of Science in India, (1938-50) Section VII, Zoology, pp. 92-151 published by the N.I.S.I.).

APPENDIX

UMASVATI'S CLASSIFICATION

of Kshudrajantu

(including small animals Invertebrata—boneless and without red-blood.)



- Ayônija
  - Svêdaja
  - Udvijja (no examples given)
- Yônija
  - Matsya
    - Sea
    - River
    - time—makara (whale) (shark)
  - Uraga or Sarpa (Ophidia)
    - Venomous (3 species)
    - Non-venomous (one species) and 80 varieties based on scale-markings.
    - Hybrid (one species)
  - Bhujanga (quadrupedal and 5-clawed)
    - Batrachie & Reptilia (8 species of frogs)
  - Lomapaksha pakshi (Aves)
    - Plava — aquatic or amphibious
    - Viskira
Pratuda } Passeres, Columbae, etc.
    - Prasaha—birds of prey.

Krimi Apādika	Platyhelminthes Nemathelminthes
	(Annelida)
Nūpuraka	... Oligochaeta
Jalūka	... Hirudinea
Gandupāda	*Arthropoda*
Pipīlika Rôhinika	Hymenoptera
Bhramara Varāta and Sāranga	„
Upāchika Kunthu Tuburaka	Hemiptera
	Coleoptera
Tailakīta Khadyôta	oil-worm glow-worm
Utpātaka Trinapatra	Aptera Thysanoptera ?
Kāshtha naraka	—Neuroptera
Makshika Mashaka Puttika Dansa	Diptera
Kīta	... Lepidoptera
Patanga	... Orthoptera
Vrischika Nandyāvartha	Arachnida
Satapādi	Myriapoda
Kôsastha (living in shells)	*Mollusca*
Sankha	Gastropoda (short-spired)
Sambuka Vodika	Helicoid and long-spired
Sūktika	Lamellibranchia

VII. REFERENCES

Ali, Sâlim A. (1927–28) : The Moghul Emperors of India as Naturalists and Sportsmen. *JBNHS*, Part I **31** (4) : 833–861 ; Parts II and III **32** (1) : 34–63 ; (2) : 264–273.

Ashraf, Kunwar Muhammad (1935) : Life and Conditions of the People of Hindusthan (1200–1550 A.D.) mainly based on Islamic Sources. *Journ. Asiatic Society of Bengal.* Third series **1** : 103–359.

Gravely, F. H. (1921) : History of Zoology in India and Ceylon.—*Proc. Asiatic Soc. Bengal*, N. S. **17** : cxxxii—cxlvi.

Hora, S. L. (1935) : Ancient Hindu Conception of Correlation between Form and Locomotion of Fishes. *Journ. Asiatic Soc., Bengal*, **1** : 1–7.

— — (1948) : Sanskrit names of Fish and their Significance. *Journ. Roy. Asiatic Soc. Bengal Science* **14** (1) : 1–6.

— — (1948) : Knowledge of the Ancient Hindus concerning Fish and Fisheries of India I. References to Fish in Arthasastra (*ca.* 300 B.C.), Ibid : 7–10.

— — (1950) : II Fishery Legislation in Asoka's Pillar Edict V (246 B.C.) *Journ. Roy. Asiatic Soc. Bengal*, Letters **16** (1) : 43–53.

— — (1951) : III Matsyavinoda or a Chapter on Angling in the Manasollasa by King Someswara (1127 A.D.), Ibid, **17** (2) : 145–169, pls. xviii-xxi.

— — (1951) : Zoological Knowledge with Special Reference to Fish and Fisheries in India before 225 B.C. *Archiv. Internat. D. Hist. Sci.* **15** : 405–412.

— — (1951) : Maintenance of Irrigation Tanks through Fishery Revenue in Ancient India. *Journ. Roy. Asiatic Soc. Bengal*, Letters, **17** (1) : 41–50.

— — (1951) : A Sanskrit work on Angling of the Early Twelfth Century. *Nature*, **167** : 778.

— — (1951) : History of Science and Technology in India and South East Asia. *Nature*, **168** : 1047.

— — (1952) : Central Board for Wild Life—*Science & Culture*, **18** (11) . 512–515.

Macdonell, A. A. and Keith A. B. (1912) : Vedic Index of Names and Subjects (Indian Texts Series)—John Murray, London.

Marshall, John (1931) : Mohenjodaro and the Indus Civilisation. Arthur Probsthain, London.

Piggot, Stuart (1952) : Prehistoric India (Pelican Books A 205), 293 pp.

Panikkar, N.K. (1956) : Fish and Fisheries in ' Progress of Science in India ', 1938–50, Section VIII, Zoology, by H. Srinivasa Rao. Nat. Inst. Sci. India, Subsection III, Fish and Fisheries, pp. 92-151.

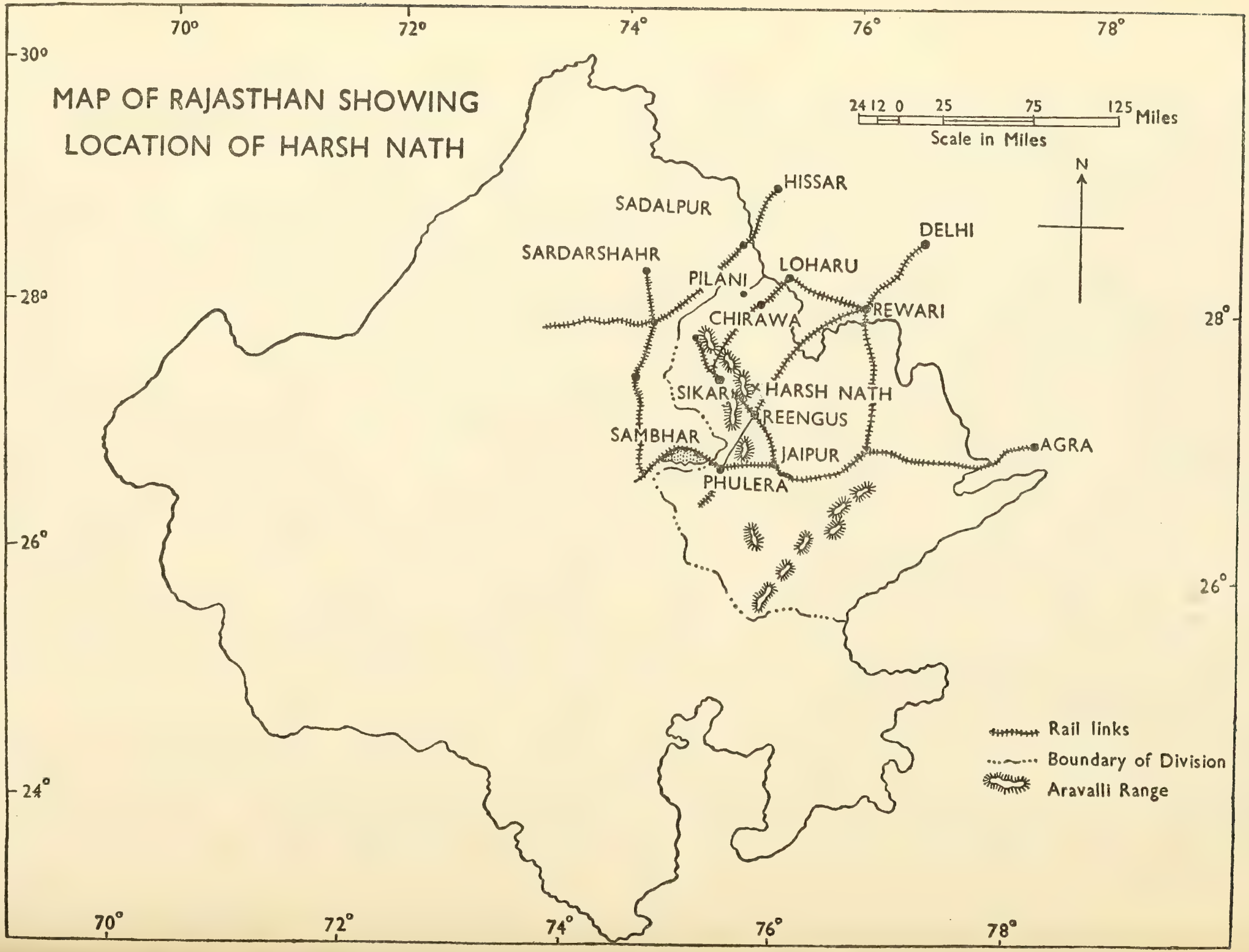
Prashad, Baini (1932) : Some Pre-Linnaean Writers on Indian Zoology, *Acharya Ray Commemoration Volume*, pp. 68–76 (Calcutta).

Prater, S. H. (1948) : The Book of Indian Animals—pp. xxxii and 263, pls. 101 and 1 map. Bombay Natural History Society.

Rao, H. Srinivasa (1938) : An Outline of the Fauna of India. ' An Outline of the Field Sciences of India ' by S. L. Hora. Ind. Sci. Congress Assn. Silver Jubilee Session, 1938, pp. 91–124, pls. v–vii.

— — (1938) : Progress of Zoology in India during the past twenty five years. ' Progress of Sciences in India ' by B. Prashad. Indian Sci. Congress Association Silver Jubilee, 1938, pp. 353-433

Seal, B. N. (1915) : The Positive Sciences of the Ancient Hindus—Hindu Classification of Animals—pp. 177–201 (London).



MAP OF RAJASTHAN SHOWING LOCATION OF HARSH NATH

70°
72°
74°
76°
78°
30°
28°
26°
24°
24 12 0 25 75 125 Miles
Scale in Miles
N
HISSAR
SADALPUR
DELHI
SARDARSHAHR
PILANI
LOHARU
CHIRAWA
REWARI
SIKAR
HARSH NATH
REENGUS
SAMBHAR
JAIPUR
PHULERA
AGRA
Rail links
Boundary of Division
Aravalli Range

VEGETATION OF HARSH NATH, ARAVALLI HILLS

BY

N. C. NAIR & G. S. NATHAWAT,

Department of Botany, Birla College, Pilani, India

(*With a map*)

INTRODUCTION

Thanks to the facilities afforded by the Birla College of Science, Pilani, it became possible to undertake the much desired survey of the vegetation of Harsh Nath in the early part of October 1955, when a large number of plants were collected in addition to a considerable amount of field notes and ecological data. Unfortunately the time at our disposal was short for any but a superficial study. Nevertheless, it must be mentioned, the study has enabled us not only to compare the various communities encountered, in terms of their perennial components, which constitute the structural framework of the vegetation, but also to observe the herbaceous plants that come out during the rainy season and the early winter plants. The aim of the present paper is to place on record the present floristic and ecological features of the vegetation so as to provide a basis for comparison at some future date.

PHYSIOGRAPHY AND GEOLOGY

The Aravalli Hills, the weather-worn remnants of an ancient chain of mountains that came into existence during the great organic upheaval towards the close of the Dharwar era, are a great feature of Rajasthan. Harsh Nath is one of the highest peaks in this ancient mountain system. It is situated 27° 37′ N. and 75° 8′ E., close to the north-eastern extremity of the range. In shape it is long and narrow but the top spreads out into an irregular picturesque plateau about five miles in length and three miles in breadth. The place commands a superb view of its environs; the succession of hills, the views of the plains and silvery sand dunes from them, and the varied greenness, all combine to form a view of the most charming scenery. The direction of the hill is south-west to north-east. The highest point in the hill is about 3,000 ft. above sea-level. Here there are a few shrines—the remnants of a glorious past—that are regarded with sentimental attachment by millions of people. The hill is not far from the beaten track, seven miles south-east of Sikar, from where a motorable road leads right up to its foot. One reaches the top by a zigzag path about three miles long.

The north-western face of the hill is rather steep and the vegetation is comparatively thick. On the northern face a lot of biotic disturbances are at work, particularly due to the removal of rocks for construction and other purposes. At lower levels a lot of earth-cutting is done. At the foot of the hill on the eastern side is the village of Harsh. The horseshoe shaped hill is surrounded on the western, northern and eastern sides by a small, purely rain-fed stream which remains dry during most part of the year. In the south and south-east are several small barren hills of the Aravallis, from which Harsh Nath is clearly separated.

The hill is rugged in outline and the rocks are highly crystalline, consisting of schists and quartzites. The important minerals of the Aravallis are mica, copper, quartz, etc. (see Wadia, 1944).

CLIMATE

The paucity of climatic data available for Harsh Nath prevents us from presenting anything other than those of the close-by station Sikar. The climate is dry. The rainy season is short, lasting from the end of June to the middle of September. The remaining period of the year is practically free from rain ; sometimes, however, a few showers fall during the winter months.

The annual mean maximum temperature varies between 72.9°F. in January and 107.9°F. in June, the average for the twelve months being 90.5° F. The mean minimum temperature varies from 41.5° F. in December to 83.5° F. in June. The highest maximum record is 115° in May and the lowest minimum 25° F. in the month of December.

The average rainfall per year is 16.95 inches distributed over 28.5 rainy days. Most of it is due to the south-west monsoon from the middle of June to the middle of September. Thunder storms sometimes occur.

There is a constant breeze from south-west to north-east and the speed varies from 1-8 miles per hour in November to 7-20 miles per hour in June. Dust storms are frequent in the months of May and June. The relative humidity attains its maximum in August and September, 80 and 76 respectively. The lowest 33 is reached in April.

SOIL

The water table seems to be very deep. The capacity of the rocks to hold water is very limited and the greater portion of the monsoon rain is washed off into the plains where it gets collected in temporary ponds.

The soil supporting plant growth consists of small pieces of gravel and rocks derived from the disintegration of gneisses and schist. It is rather thin and contains a variety of humus derived from decaying plant and animal remains. Wherever the locality is rich in biological soil formed due to human agency by the addition of animal excreta and other manure the vegetation is comparatively rich.

VEGETATION

During the present study the top of the hill was approached from four sides in parties of three each. The vegetation falls naturally into interesting and fairly distinct elevational zones though they intermingle to a certain extent and merge with one another, so that very clear limits cannot be assigned to each. Some of the elements that constitute the vegetation are present throughout the hill, e.g. *Tephrosia purpurea*, *Cenchrus catharticus*, *Boerhaavia diffusa*, *Peristrophe bicalyculata*, etc.

Certain plants, such as *Adhatoda vasica*, *Indigofera* sp., *Capparis decidua*, etc., were found only at the base and top of the hill.

The account of the vegetation of Harsh Nath will be incomplete without a general account of the vegetation of the neighbouring plains around the hill. The general structure of the vegetation of the plains is similar to that of other arid regions of Rajputana and corresponds to the dry semi-desertic type of vegetation. As might be expected, thorny plants figure prominently. In spread out sand the early pioneers to colonise are *Aerua tomentosa*, *Crotalaria burhia*, *Leptadenia spartium*, etc. In some places colonies of *Aerua tomentosa*, *Leptadenia spartium*, *Calligonum polygonoides*, *Panicum turgidum*, etc. are found. Relatively thick growth occurs in places and the principal associations are

(*a*) PROSOPIS-CAPPARIS association
Prosopis spicigera. d
Capparis decidua. c
Anogeissus pendula. r
Zizyphus rugosa. r
Calotropis procera. r
Salvadora persica. r
Aerua tomentosa. c
Boerhaavia diffusa. c
Polygala erioptera. r
Corchorus acutangulus. c

(*b*) BALANITES-ANOGEISSUS association
Balanites roxburghii. d
Anogeissus pendula. c
Zizyphus rugosa. r
Calotropis procera. r
Clerodendrum phlomidis. r
Aerua tomentosa. c
Corchorus acutangulus. r
Abutilon indicum. r

(*c*) CAPPARIS-SACCHARUM association (on stabilized dunes)
Capparis decidua. d
Saccharum munja. c
Calotropis procera. r
Clerodendrum phlomidis. r
Cleome viscosa. r
Corchorus tridens. r
Coccinia indica. r
Cenchrus catharticus. c
Gisekia pharnaceoides. a

(*d*) BALANITES-ACACIA association
Balanites roxburghii. d
Acacia arabica. c
Prosopis spicigera. r

---

* d dominant ; a abundant ; c common ; r rare

Zizyphus rugosa. r
Solanum nigrum. r
Tephrosia purpurea. c
Withania somnifera. r
Citrullus colocynthis. r
Sida cordifolia. r
Commelina benghalensis. r

(*e*) GYMNOSPORIA-CAPPARIS-ZIZYPHUS association
Gymnosporia montana. d
Capparis decidua. c
Zizyphus rugosa. a
Leptadenia spartium. r
Calotropis procera. r
Abutilon indicum. r
Aerua tomentosa. c
Cenchrus biflorus. a
Dactyloctenium aegypticum. a
Tribulus terrestris. r
Mollugo nudicaulis. r

(*f*) ZIZYPHUS-CALLIGONUM association
Zizyphus rugosa. c
Callygonum polygonoides. c
Aerua tomentosa. r
Leptadenia spartium. r
Corchorus tridens. r
Argemone mexicana. r
Vernonia cinerea. r
Boerhaavia diffusa. r

(*g*) TEPHROSIA-CORCHORUS association (in open sand)
Tephrosia purpurea. c
Corchorus tridens. r
Corchorus acutangulus. r
Mollugo cerviana. c
Mollugo nudicaulis. c
Gisekia pharnaceoides. c
Spermacoce hispida. r
Polygala erioptera. r

(*h*) AMARANTUS-ALTERNANTHERA association (in moist soil of partly dried up ponds)
Amarantus spinosus. a
Alternanthera sessilis. a
Calotropis procera. r (in seedling stage only).
Polygonum plebejum. c
Mollugo hirta. c
Argemone mexicana. r
Eclipta erecta. r
Cyperus rotundus. r

(*i*) SMITHIA-MOLLUGO association (in moist soil around ponds)

Smithia sensitiva. d
Mollugo hirta. a
Eclipta erecta. r
Alternanthera sessilis. c
Cyperus rotundus. r
Cynodon dactylon. r
Polygonum plebejum. c

Foot of the hill. The vegetation at the foot of the hill and up to 1,500 ft. consists mainly of shrubs with trees here and there. The plants that are common in the plains, diminish gradually from the base upwards. The vegetation in the zone shows a remarkable uniformity, and the elements that constitute the shrubby community are

Adhatoda vasica. d
Zizyphus rugosa. c
Tephrosia purpurea. c
Clerodendrum phlomoidis. r
Calotropis procera. r
Aerua tomentosa. r
Gymnosporia montana. r

The tree species found in this zone are *Balanites roxburghii*, *Wrightia tomentosa*, *Tamarix articulata*, *Prosopis spicigera*, *Anogeissus pendula*, *A. latifolia*, and *Salvadora persica.*

Between 1,500 and 2,000 ft. As the proximity of this zone is reached *Adhatoda*, *Calotropis*, and *Clerodendrum* drop away, and their places are taken by new elements and stunted trees become more and more prominent. In this zone the prominent plants are

Anogeissus latifolia. c
Prosopis spicigera. c
Wrightia tomentosa. r
Acacia senegal. r
Gymnosporia montana. c
Dichrostachys cinerea. r
Euphorbia neriifolia. r
Dichoma tomentosa. c
Triumpheta rhomboidea. r

Above 2,000 ft. There is a remarkable change in the vegetation above this level. The trees become more and more prominent. They branch profusely and form a canopy. The prominent trees are

Anogeissus latifolia. a
Salvadora oleoides. r
Cedrela toona. c
Holoptelea integrifolia. r
Wrightia tomentosa. c
Prosopis spicigera. r
Acacia senegal. r

On the boulders and in the crevices and pockets of rocks, where some soil has been collected, *Euphorbia neriifolia*, *Blainvillea rhomboidea*, *Digitaria adscendens*, etc. grow. At places, pure colonies of *Euphorbia neriifolia* are met with. The shrubby plants of this zone are

Gymnosporia montana. c
Dychrostachys cinerea. r
Blepharis boerhaaviaefolia. c
Peristrophe bicalyculata. c
Abutilon indicum. r
Sida humilis. r

The herbaceous vegetation consists of

Physalis minima. c
Polycarpaea corymbosa. r
Zornia diphylla. c
Cucumis trigonus. c
Arnebia hispidissima. c
Boerhaavia repens. c
Euphorbia hypericifolia. r
Melhania tomentosa. r
Actinopteris dichotoma. c
Adiantum annulatum. c

The common bryophytes are *Riccia*, *Funaria*, and *Fimbriaria.*

Such areas with good vegetation are not many in Harsh Nath. The highest point and the greater part of the tableland are practically devoid of vegetation except for some stunted plants of *Anogeissus latifolia*, *Euphorbia neriifolia*, and thalloid plants such as lichens, etc.

In some of the valleys were observed luxuriant growth of bamboos. At the highest point there are a few artificial ponds in which were seen *Lemna.* Around these ponds the soil supports a thick growth of *Bambusa*, *Anogeissus*, *Holoptelea*, *Salvadora*, *Acacia*, *Prosopis*, and shrubs such as *Zizyphus xylopora*, *Capparis decidua*, *Abutilon indicum*, *Bauhinia* sp., *Adhatoda vasica*, *Peristrophe bicalyculata*, and herbs such as *Boerhaavia diffusa*, *Elytraria crenata*, *Trianthema pentandra*, *Aristolochia bracteata*, *Oldenlandia corymbosa*, *Elephantopus scaber*, *Heliotropium subulatum*, *Indigofera argentea*, *Tridax procumbens*, *Sonchus* sp., etc.

DETAILED LIST OF PLANTS COLLECTED

Menispermaceae

Cocculus villosus DC. Rare; vegetative.

Papavaraceae

Argemone mexicana Linn. This winter plant was seen flowering in several places in the vicinity of temporary ponds.

Cruciferae

Farsetia jacquemontii Hook. Common in the plains. Flowering.

F. hamiltonii Royle. Flowering and fruiting. Rare.

Capparidaceae

Cleome viscosa Linn. Rare. Flowering and fruiting.

Cleome papillosa Steud. Rare, flowering.

Capparis decidua Pax. Vegetative. Common.

Gynandropsis pentaphylla DC. Common in the plains. Flowering and fruiting.

Caryophyllaceae

Polycarpaea corymbosa Lamk. Fruiting.

Polygalaceae

Polygala erioptera DC. Common. Flowering and fruiting.

P. abyssinica Presh. Flowering. Rare.

Portulacaceae

Portulaca quadrifida Linn. Rare. Flowering.

P. oleracea Linn. Rare.

Tamaricaceae

Tamarix articulata Vahl. Rare; vegetative.

Malvaceae

Sida cordifolia Linn. Flowering. Common.

S. rhombifolia Linn. Flowering. Rare.

S. humilis Willd. (=*Sida veronicaefolia* Lamk.) An under-shrub. Rare, flowering.

Pavonia zeylanica Cav. Flowering. Common.

Malvastrum tricuspidatum A. Grey. Rare, fruiting.

Abutilon indicum Linn. Common, flowering.

Sterculiaceae

Melhania tomentosa Stocks. Flowering. Rare. Erect tomentose herb. Flowers yellow. Fertile stamens five alternating with five staminodes.

Tiliaceae

Triumpheta rhomboidea Jacq. Flowering. Common.

Corchorus acutangulus Lamk. Flowering. Common.

Corchorus trilocularis Linn. Flowering. Common.

Corchorus tridens Linn. Flowering. Common.

Grewia populifolia Vahl. Rare, flowering.

Zygophyllaceae

Tribulus terrestris Linn. Common. Fruiting.

Tribulus alatus Del. Flowering. Common.

Fagonia arabica Linn. Fruiting. In the plains. Rare.

Simaroubaceae*

Balanites roxburghii Plan. Common.

Ailanthus excelsa Roxb. Rare.

Meliaceae

Azadirachta indica Lamk. Cultivated.

Melia azedarach Linn. Cultivated.

Cedrela toona Roxb. Only on the higher altitudes of the hill. Vegetative.

Celastraceae

Gymnosporia montana Roxb. Flowering. Common.

Rhamnaceae

Zizyphus xylopyra Willd. Vegetative, abundant at the foot of the hill and in the plains.

Z. nummularia W. & A. Common in the plains. Flowering.

Z. jujuba Lamk. Cultivated.

Sapindaceae

Cardiospermum halicacabum Linn. Common in the higher altitudes of the hill. Flowering.

Leguminosae

Indigofera linifolia Retz. Flowering. Rare in the plains.

Indigofera argentea Linn. Flowering. Common in the plains. One of the pioneers in fresh sand dunes.

Indigofera cordifolia Heyne. Common. Flowering.

Indigofera tinctoria Linn. A few plants on the roadside. Probably cultivated.

Indigofera enneaphylla Linn. Flowering. Common.

---

* This family name is based on that of its type genus *Simarouba*, established and so spelled by Aublet to commemorate the barbaric Carib name for plants of the genus. The spelling was changed by de Candolle in 1811 to *Simaruba*, but as pointed out by Sprague (Kew Bull. 1929 p. 243) the original spelling must be used.

Indigofera pentaphylla Linn. Flowering. Rare.

Indigofera triquetra Dalz. A wiry small herb. Common, flowering.

Indigofera wightii Carab. Flowering and fruiting. Rare. This plant with its silvery foliage was found to reach a height of 4–5 ft., although the normal height reported is 2–3 ft.

Tephrosia purpurea Pers. Flowering. Abundant both in the hill and in the plain.

Tephrosia tenuis Vahl. Rare. Flowering.

Smithia sensitiva Ait. Flowering and fruiting. A shrub 1–2 feet high. Common at the base of the hill near ponds.

S. dichotoma Dalz. Rare. Flowering.

Zornia diphylla Pers. Common throughout the hill. Flowering.

Crotalaria burhia Hamilt. Common on the plains. One of the dune pioneers. Flowering.

Desmodium gangeticum DC. Rare. Flowering.

Dalbergia sissoo Roxb. A few plants in the village Harsh. Seems to be cultivated.

Melilotus alba Lamk. A few plants at the base of the hill near temporary ponds. Flowering.

Cyamopsis psoralioides DC. Cultivated and spread from the fields.

Phaseolus mungo var. **radiatus.** Cultivated.

P. vulgaris Linn. Cultivated.

Phaseolus aconitifolius Jacq. Cultivated.

Cassia occidentalis Linn. Rare, flowering and fruiting.

Cassia tora Linn. Common both in the plains and on the hill. Flowering.

Bauhinia racemosa Lamk. Small trees in the higher altitudes of the hill. Common.

Tamarindus indica Linn. Cultivated.

Dichrostachys cinerea W. & A. Flowering, rare.

Acacia arabica Willd. Rare.

Acacia senegal Willd. Common on the hill.

Acacia leucophloea Willd. Common in the plains.

Acacia jacquemontii Benth. Common in the plains. Flowering.

Prosopis spicigera Linn. Abundant.

Albizzia lebbeck Willd. Cultivated.

Mimosa hamata Willd. Common in the plains. Flowering.

Combretaceae

Anogeissus pendula Edgw. Flowering; rare on the hill. Common in the plains.

Cucurbitaceae

Cucumis trigonus Roxb. Flowering and fruiting. Rare.

Cucumis sativus Linn. Cultivated, often runs wild.

Momordica dioica Roxb. Rare, flowering and fruiting.

Momordica balsamina Linn. Flowering and fruiting. Not uncommon.

Momordica charantia Linn. Cultivated.

Citrullus colocynthis Schrad. Common in the plains. One of the dune pioneers. Generally has long and trailing branches.

Citrullus vulgaris Schrad. Cultivated.

Ctenolepis cerasiformis Naud. Climbing, scabrous herbs with simple tendrils. Leaves simple, orbicular 5–7–lobed, middle lobe acute longer than the others. Flowers monoecious; male on small inconspicuous axillary peduncles, females solitary in the same axil of the male. The stipuliform bract is the characteristic feature of the species.

Luffa acutangula Roxb. Cultivated, fruiting.

Cucurbita maxima Duch. Cultivated. Flowering and fruiting.

Lagenaria vulgaris Ser. Cultivated.

Trichosanthes sp. Cultivated.

Luffa aegyptiaca Mill. Cultivated, fruiting.

Cephalandra indica Naud. Rare, flowering.

Ficoideae

Trianthema monogyna Linn. In moist places. Common. Flowering.

T. pentandra Linn. Flowering and fruiting. Common.

T. crystallina Vahl. Rare.

Mollugo cerviana Seringe. Flowering and fruiting. Common on fresh sand dunes and rarely in association with other plants. One of the dune pioneers.

M. nudicaulis Lamk. (as above)

M. hirta Thunb. Flowering. In moist places and in dried up temporary ponds.

Gisekia pharnaceoides Linn. Flowering and fruiting. Common in loose sand.

Cactaceae

Opuntia dillenii Haw. Rare. Vegetative.

Umbelliferae

Daucus carota Linn. Vegetative. Cultivated.

Coriandrum sativum Benth. Vegetative. Cultivated.

Rubiaceae

Spermacoce hispida Linn. Flowering and fruiting. Common in the plains.

S. stricta Linn. (As above)

Oldenlandia umbellata Linn. Fruiting. Common.

Oldenlandia brachiata Hk. f. Flowering and fruiting. Common.

Oldenlandia corymbosa Linn. Flowering and fruiting. Rare.

Compositae

Blainvillea rhomboidea Cass. Flowering. Common.

Dicoma tomentosa Cass. Flowering.

Eclipta alba Hassk. Common in moist places, flowering.

Glossocardia linearifolia Cass. Flowering. Rare.

Bidens pilosa Linn. Flowering. Common.

Vernonia cinerea Linn. Flowering. Common.

Ageratum conyzoides Linn. Flowering. Rare.

Pulicaria wightiana Clarke. Common in the plains. Flowering.

Elephantopus scaber Linn. Rare. In shade, flowering.

Tridax procumbens Linn. Abundant. Flowering.

Cnicus wallichii DC. Flowering. Common.

Launea pinnatifida Cass. Flowering. Rare.

Launea nudicaulis Less. Flowering. Rare.

Sonchus oleraceus Linn. Flowering. Rare.

Sonchus arvensis Linn. Flowering. Rare.

Sonchus asper Vill. Flowering. Rare.

Artemisia scoparia Wald. Flowering. Common.

Blumea lacera DC. Flowering. Rare.

Xanthium strumarium Linn. Flowering. Common at the base, particularly in moist situations.

Vernonia conyzoides Wight. Flowering. Rare.

Salvadoraceae

Salvadora persica Linn. Vegetative. Common on the hill. Not in the plains.

Salvadora oleoides Decne. In the plains, rarely on the hill. Vegetative.

Apocynaceae

Wrightia tomentosa Roem. Common on the hill, not in the plains. Flowering.

Lochnera pusilla Flowering. Rare.

Vinca rosea Linn. Cultivated.

Asclepiadaceae

Leptadenia spartium Wight. Flowering. Common in the plains. One of the pioneers in fresh sand.

Ceropegia tuberosa Roxb. Flowering. Rare.

Calotropis procera R.Br. Flowering. Common in the plains. Rarely on the hill up to 1,500 ft. One of the pioneers in fresh sand.

Calotropis gigantea Br. Common in the plains.

Boraginaceae

Arnebia hispidissima DC. Throughout hill, flowering.

Heliotropium zeylanicum Lamk. Flowering. Common.

Heliotropium eichwaldii Steud. Flowering. Common.

Heliotropium undulatum Vahl. Common in the shade afforded by other plants.

Heliotropium indicum Linn. Flowering. Common.

Trichodesma amplexicaule Roth. Flowering. Common.

Cordia myxa Linn. A few plants at the foot of the hill. Probably cultivated.

Sericostoma pauciflorum Stocks. Flowering. Common in the plains.

Solanaceae

Withania somnifera Dunal. Flowering. Common at the foot of the hill.

Solanum nigrum Linn. Common. Flowering.

Solanum xanthocarpum Ster. Flowering. Rare, in the plains.

Solanum indicum Linn. Flowering. Rare, on the hill.

Solanum melongena Linn. Cultivated.

Physalis minima Linn. Flowering.

Physalis peruviana Linn. Flowering.

Datura fastuosa Linn. Flowering. Rare.

Lycium europeum Linn. Flowering. Common in the plains both in loose and stabilized soil.

Capsicum frutescens Linn. Flowering. Cultivated.

Convolvulaceae

Evolvulus alsinoides Linn. Common both in the hill and in the plains.

Cuscuta hyalina Roth. Parasite on *Trianthema*, *Tribulus*, etc. at the base of the hill.

Cuscuta reflexa Forsk. Rare. Parasite on *Adhtoda vasica* at the base of the hill.

Ipomoea vitifolia Sweet. Flowering. Rare.

Ipomoea turpethum Br. Flowering. In the hill. Rare.

Ipomoea pestrigridis Linn. Rare. In plains.

Merremia hastata Hallier. Flowering. Throughout the hill.

Scrophulariaceae

Lindenbergia urticaefolia Lehm.

Lathrea squamaria Linn. Root parasite on *Euphorbia neriifolia.* Common.

Linaria cabulica Benth. Common from 1,200 ft. to 1,600 ft. Flowering.

Scoparia dulcis Linn. In moist places at the base of the hill.

Striga lutea Linn. Root parasite on *Pennisetum typhoideum.*

Anticharis linearis Hochst. Flowering. Common in the plain.

Bignoniaceae

Tecoma undulata G. Don. Common in the plains. One of the principal trees of the area.

Pedaliaceae

Pedalium murex Linn. At the base of the hill. Common in sandy areas. Flowering.

Sesamum indicum DC. Flowering. Stray plants here and there. Probably spread from the fields.

Acanthaceae

Justicia procumbens Linn. One of the most abundant herbaceous plants, flowering.

Justicia simplex Don. Smaller than the above species. Flowering. Frequent.

Justicia heterocarpa T. Anders. Flowering. Rare, only in the hill.

Peristrophe bicalyculata Nees. Abundant at the base and top of the hill in moist situations.

Ruellia prostrata Lamk. Flowering. Common.

Elytraria crenata Vahl. Flowering. Rare; one of the shade-loving plants.

Adhatoda vasica Nees. Abundant at the base and top of the hill.

Blepharis boerhaaviaefolia Pers. Flowering. Prostrate undershrub. Common.

Verbenaceae

Clerodendrum phlomidis Linn. Flowering. Common.

Stachytarpheta indica Vahl. Flowering. Rare.

Labiatae

Leucas aspera Spreng. Flowering. Common.

Leucas urticaefolia Br. Flowering, rare, only in the hill.

Leucas ciliata Benth. Flowering. Rare.

Ocimum basilicum Linn.

Ocimum sanctum Linn. In the neighbourhood of villages, and near temples at the top on the hill. Flowering.

Ocimum canum Linn. Flowering. Rare. From 1,000 ft. to 2,000 ft.

Nyctaginaceae

Boerhaavia diffusa Linn. Flowering. Common.

Boerhaavia repens Delile. Flowering. Common.

Amarantaceae

Aerua tomentosa Forsk. Flowering. Common in the plains. A pioneer species on the sand dunes.

Aerua lanata Juss. Rare.

Amarantus spinosus Linn. Flowering. Common at the base of the hill in moist places.

Amarantus viridis Linn. Flowering. Common in the plains.

Amarantus gangeticus Linn. Flowering. At the base of the hill in moist places.

Amarantus sp. Very tall, 9–12 ft., with long spines; near cultivated fields.

Achyranthes aspera Linn. Flowering. Common in the plains.

Alternanthera sessilis Br. In moist places at the base of the hill.

Digera arvensis Forsk. Flowering. Common in the plains.

Celosia argentea Linn. Flowering. Common at the base of the hill.

Pupalia lappacea Moq. Flowering and fruiting. Common; a shade-loving plant of the plains found in association with *Zizyphus*, *Calotropis*, etc.

Nothosaerua brachiata Wight. Flowering. Common near waterlogged areas.

Chenopodiaceae

Chenopodium album Linn. Flowering. Common in the fields.

Chenopodium murale Linn. In moist places.

Polygonaceae

Calligonum polygonoides Linn. Vegetative, common in the plains. One of the dune pioneers. Sometimes it prefers to grow at the very crest of dunes.

Polygonum plebejum Br. Common near temporary ponds. Flowering.

Aristolochiaceae

Aristolochia bracteata Retz. At the foot of the hill and in the plains, in the shade and in open sandy soil. Flowering and fruiting.

Loranthaceae

Loranthus longiflorus Pers. Flowering. Parasite on *Holoptelea*, *Cedrela*, etc.

Euphorbiaceae

Euphorbia hypericifolia Linn. Common.

Euphorbia hirta Linn. Common in moist situations. Flowering. (syn. *E. pilulifera* L.)

Euphorbia neriifolia Linn. Common on the hill.

Euphorbia microphylla Heyne. Common, flowering.

Euphorbia clarkeana Hook. Common. Flowering.

Phyllanthus madraspatensis Linn. Flowering. Common.

Phyllanthus niruri Linn. Rare.

Chrozophora obliqua A. Juss. A tomentose small shrub 1–3 ft. high Flowering. Common in the plains.

Acalypha ciliata Forsk. Flowering. Rare. In the higher altitudes of the hill.

Ricinus communis Linn. Flowering. Cultivated and running wild.

Urticaceae

Ficus religiosa Linn. Flowering and fruiting. Rare. Probably all cultivated plants.

Ficus benghalensis Linn. Only four plants at the base of the hill (Harsh Village) and two plants at the top. Probably cultivated.

Holoptelea integrifolia Planch. Vegetative. Rare.

Morus alba Linn. In the Village. Probably cultivated. Vegetative.

Liliaceae

Asparagus racemosus Willd. Vegetative, at the base of the hill.

Asphodelus tenuifolius Cav. A common weed of the cultivated fields.

Allium cepa Linn. Cultivated.

Commelinaceae

Commelina benghalensis Linn. Flowering. Common in moist shady places.

Commelina obliqua Buch.-Ham. At higher altitudes. Common.

Cyanotis (axillaris Roem ?) Common.

Palmae

Phoenix sylvestris Roxb. In the plains.

Lemnaceae

Lemna trisulca Linn. Vegetative. Common in the artificial ponds at the top of the hill.

Cyperaceae

Cyperus rotundus Linn. Frequent in moist places.

Cyperus arenarius Retz. Flowering. Common.

Fimbristylis squarrosa Vahl. Flowering. Rare.

Scirpus maritimus Linn. Rare.

Gramineae

Aristida histricula Edgew.

Aristida depressa Retz.

Cenchrus catharticus Del.

Cenchrus prurii (Kunth) Maire.

Cenchrus biflorus Roxb.

Saccharum munja Roxb.

Saccharum spontaneum Linn.

Cynodon dactylon Pers.

Digitaria adscendens (H. B. K.) Henr. (=*Panicum adscendens* H. B. K.)

Digitaria marginata Link.

Chloris barbata Sw.

Panicum turgidum Forsk.

Panicum antidotale Retz.

Dactyloctenium aegyptium Willd.

Brachiaria ramosa Stapf (= *Panicum ramosum* Linn.)

Sporobolus orientalis Kunth.

Bambusa bambos Vilm.

Urochloa panicoides Beauv.

Pennisetum typhoideum Rich. Cultivated.

Zea mays. Cultivated.

Sorghum vulgare. Cultivated.

Gnetaceae

Ephedra foliata Boiss. Common in the plains.

STATISTICAL SYNOPSIS

Table I gives the number and percentage of families, genera, and species of each class.

Table I

	Dicotyledons		Monocotyledons		Total
	%	No.	%	No.	
Families	88·24	45	11·37	6	51
Genera	85·62	126	14·38	21	147
Species	87·00	194	13·00	29	223

Excepting Gramineae, the Monocotyledons are poorly represented. Of the 29 species of Monocotyledons 18 belong to Gramineae while the rest belong to 5 different families. Excepting the families Leguminosae and Compositae, the Dicotyledons are also poorly represented. Of the 194 species of Dicotyledons, 27 belong to Leguminosae, 20 belong to Compositae, while the remaining 147 belong to 43 different families.

The ratio of Monocotyledons to Dicotyledons is 1 : 7·5 of families, 1 : 6 of genera, and 1 : 6·7 or species. The ratio of genera to species is 1 : 1·53. This ratio indicates the small proportion of species to the genera and families.

Out of 51 families, 23 are represented by one genus each and of these 15 have only a single species each. Of the remaining 36 families 10 have 2 genera each, 5 have 3, 3 each have 4 and 5 genera, 2 have 6 genera, 1 has 8 genera, 2 have 13 genera, and 1 has 16 genera.

The families having 8 or more genera are Amarantaceae (8), Leguminosae (13), Graminae (13), and Compositae (16).

Of the 147 genera 101 are represented by a single species each, 29 by 2 species, 13 by 3, and 3 by 4 species. The remaining 2 genera have 5 and 8 species.

The largest families having 6 or more species are Malvaceae (6), Leguminosae (27), Cucurbitaceae (6), Ficoideae (7), Compositae (20), Boraginaceae (8), Solanaceae (8), Convolvulaceae (7), Scrophulariaceae (6), Acanthaceae (8), Labiatae (6), Amarantaceae (11), Euphorbiaceae (10), and Gramineae (18). Leguminosae, Compositae, Gramineae, Amarantaceae, and Euphorbiaceae make more than one-third of the flora.

The various genera are very poorly represented. The largest genera having 4 or more species are *Indigofera* (8), *Euphorbia* (5), *Amarantus*, *Heliotropium*, and *Acacia* (4 each).

Out of 223 species, 28 are trees, 48 are shrubs and under-shrubs, and 147 herbs. Climbing plants are represented by 17 species, and parasites by 5 species. *Cuscuta reflexa*, *Cuscuta hayalina*, *Striga lutea*, *Lathraea squamaria* and *Loranthus longiflorus* belong to the class of Parasites. Phanerogamic hydrophytes are represented by one species of *Lemna*.

The Gymnosperms are represented by a single species *Ephedra foliata*.

Geographical Distribution

The following elements can be distinguished in the flora of Harsh Nath.

(*a*) ENDEMIC ELEMENT

Triumpheta rhomboidea
Mimosa hamata
Acacia jacquemontii
Indigofera wightii
Tephrosia tenuis
Indigofera triquetra
Anogeissus pendula
Oldenlandia umbellata
Oldenlandia brachiata
Pulicaria wightiana
Vernonia cinerea
Cnicus wallichii
Ceropegia tuberosa
Leucas ciliata
Asphoedelus tenuifolius
Sida cordifolia
Dichrostachys cinerea
Pavonia zeylanica
Digera arvensis
Smithia dichotoma
Melhania tomentosa
Ailanthus excelsa
Balanites roxburghii
Anogeissus latifolia
Zizyphus xylopyra
Trichodesma amplexicaule
Lindenbergia urticaefolia
Sericostoma pauciflorum
Clerodendrum phlomoides
Stachytarpheta indica
Polygonum plebejum
Loranthus longiflorus
Euphorbia clarkeana
Ocimum basilicum
Elephantopus scaber
Acacia leucophloea
Heliotropium zeylanicum

(*b*) MALAYAN ELEMENT

Indigofera enneaphylla
Bauhinia racemosa
Solanum indicum
Ipomoea vitifolia
Cuscuta reflexa
Justicia procumbens

Cedrela toona
Spermacoce hispida
Wrightia tomentosa
Calotropis gigantea
Solanum xanthocarpum
Cyanotis axillaris
Adhatoda vasica
Leucas aspera
Euphorbia microphylla
Holoptelea integrifolia
Commelina obliqua
Spermacoce stricta

(*c*) AFRICAN-PERSIAN ELEMENT

Farsetia jacquemontii
Farsetia hamiltonii
Tamarix articulata
Tribulus alatus
Fagonia arabica
Zizyphus numularia
Indigofera pentaphylla
Polygala erioptera
Acacia arabica
Acacia senegal
Salvadora persica
Salvadora oleoides
Calotropis procera
Leptadenia spartium
Grewia populifolia
Dichoma tomentosa
Launea nudicaulis
Cordia myxa
Aerua tomentosa
Heliotropium undulatum
Ocimum canum
Cocculus villosus
Arnebia hispidissima
Leucas urticaefolia
Peristrophe bicalyculata
Withania somnifera
Callygonum polygonoides
Acalypha ciliata
Cyperus arenarius
Indigofera argentea
Crotalaria burhia
Prosopis spicigera
Citrullus colocynthis
Cleome papillosa
Capparis decidua
Polygala abyssinica
Panicum antidotale
Trianthema crystallina
Gysekia pharnaceoides
Trianthema pentandra
Ctenolepis cerassiformis
Lycium europeum
Tecoma undulata
Corchorus trilocularis
Ephedra foliata
Cuscuta hyalina
Anticharis linearis
Linaria cabulica
Pedalium murex
Pupalia lappacea
Corchorus tridens
Blepharis boerhaaviaefolia
Ruellia prostrata
Justicia heterocarpa
Aristolochia bracteata
Nothosaerua brachiata
Cenchrus catharticus

(*d*) INTRODUCED TROPICAL AMERICAN WEEDS

Argemone mexicana
Cassia occidentalis
Elytraria crenata
Bidens pilosa
Physalis peruviana
Malvastrum tricuspidatum
Scoparia dulcis
Xanthium strumarium
Tridax procumbens

Of the 223 species collected the following are new records for Rajasthan :—

Farsetia hamiltonii
Sida humilis
Malvastrum tricuspidatum
Triumpheta rhomboidea
Lochnera pusilla
Arnebia hispidissima
Heliotropium indicum
Trichodesma amplexicaule

Smithia sensitiva
Smithia dichotoma
Zornia diphylla
Dichrostachys cinerea
Ctenolepis cerassiformis
Oldenlandia umbellata
Oldenlandia brachiata
Oldenlandia corymbosa
Elephantopus scaber
Cnicus wallichii
Launea pinnatifida
Sonchus arvensis
Sonchus asper
Blumea lacera
Saccharum spontaneum
Brachiaria ramosa
Ipomoea vitifolia
Ipomoea turpethum
Lathraea squamaria
Linaria cabulica
Striga lutea
Justicia heterocarpa
Leucas ciliata
Loranthus longiflorus
Chrozophora obliqua
Cyanotis axillaris
Lemna trisulca
Fimbristylis squarrosa
Cenchrus prurii
Saccharum munja
Digitaria adscendens

SUMMMARY

Harsh Nath is one of the highest hills of the Aravalli mountains. The vegetation of the area around the hill is similar to other arid regions of Rajasthan. The vegetation of the hill shows an interesting elevational zonation. At the foot of the hill *Adhatoda* with a number of other species forms the dominating element. At about 1,500 ft. *Adhatoda* drops away and mixed associations of trees and shrubs of various families are met with. Above 2,000 ft. the trees become more and more prominent. In the valleys luxuriant growth of bamboos was observed.

Of the 223 species collected 184 are found in other parts of Rajasthan (Blatter and Hallberg, 1918–21 ; Mulay and Ratnam, 1950 ; Ramachandra, 1950 ; Sankhala, 1951 ; Sarup, 1951 ; Ratnam, 1951 ; Ratnam and Joshi, 1952 ; Biswas and Rao, 1953 ; Bakshi, 1954 ; Nair, 1955 ; Nair and Joshi, 1955). Sabnis (1929) gave an account of the principal families of the deserts of Rajasthan and Sind. He included Gramineae, Leguminosae, Compositae, Cyperaceae, Convolvulaceae, Amarantaceae, Boraginaceae, Cucurbitaceae, Acanthaceae, and Malvaceae as the dominant families of Rajputana desert. The principal families of Harsh Nath are Leguminosae (27), Compositae (20), Graminae (18), Amarantaceae (11), Euphorbiaceae (10), Acanthaceae (8), Boraginaceae (8), Solanaceae (8), Ficoideae (7), Convolvulaceae (7), Scrophulariaceae (6), Cucurbitaceae (6), Malvaceae (6), and Labiatae (6). In contrast to the vegetation in the plains of Rajputana the families Labiatae, Scrophulariaceae, and Euphorbiaceae are well represented.

Three different elements, western (African-Persian), eastern (Malayan), and Indian, are distinguished in the flora of Harsh Nath. The western element predominates over the eastern element. The eastern type is a little less than one half of the western.

We are thankful to Dr. B. N. Mulay for facilities, encouragement, and suggestions, to Rev. Fr. Santapau for kindly going through the manuscript and suggesting several improvements. We are also thankful to our students Messrs. Murali, D. Menon, C. O. Varghese, Chuda, Kan Singh Dharamjit Singh, and Miss S. R. Kahatae for assistance.

BIBLIOGRAPHY

Bakshi, T. S. (1954) : Vegetation of Pilani and its Neighbourhood. *JBNHS*, **52**: 484–514.

Biswas, K. and Rao, R. S. (1953) : Rajputana Desert Vegetation. *Proc. Nat. Inst. Sci. India.* **19**: 411–421.

Blatter, E. and Hallberg, F. E. (1918-21) : The Flora of Indian Desert. *JBNHS*, **26-27** : (different pages).

Hooker, J. D. (1885) : Flora of British India. London.

Mulay, B. N. and Ratnam, B. V. (1950) : Study of the Vegetation found round about Pilani and its Neighbourhood. *Proc. Indian Sci. Cong.* Poona. Part III : 64–65.

Nair, N. C. (1955) : Flora of Chirawa. *Proc. Raj. Acad. Sci.* **6**: 49-64.

— — — — and Joshi, M. C. (1955) : Sand Dune Vegetation of Pilani and its Neighbourhood. *Symp. Veg. Types India.* Baroda (Unpublished).

Ramachandra, K. R. (1950) : Common grasses found round about Pilani. *Proc. Indian Sci. Cong.* Poona, Part III : 65–66.

Ratnam, B. V. (1951) : Vegetation of Loharghal. *Proc. Raj. Acad. Sci.* **2** : 26–36.

— — — — — — and Joshi, M. C. (1952) : An Ecological Study of the Vegetation near about a Temporary Pond in Pilani. ibid. **3** : 1–15.

Sabnis, T. S. (1929) : A Note on the Ecology of the Flora of Sind. *J. Indian Bot. Soc.* **8** : 263–286.

Sankhala, K. S. (1951) : Enumeration of the Flowering Plants of north-western Rajasthan. *Univ. Rajputana Sci. studies* (*Biology Section*) **1** : 29-35.

Sarup, S. (1951) : A List of Common Plants of Jodhpur and its Neighbourhood. ibid. **1**: 29–35.

— — — — (1952): Plant Ecology of Jodhpur and its Neighbourhood. A Contribution to the Ecology of north-western Rajasthan. *Bull. Nat. Inst. Sci. India.* **1**: 223–232.

Weaver, J. E. and Clements, F. E. (1938) : Plant Ecology. New York.

NOTES ON THE HETEROCERA OF CALCUTTA

BY

D. G. SEVASTOPULO, F.R.E.S.

PART IV

(*Continued from page* 155 *of this Volume*)

The present, and final, paper in this series covers the Pyralidae. This is a family that is neglected by most collectors, why it is difficult to understand as, generally speaking, its members are not unduly small. Many of them are of outstanding beauty, and many others possess secondary sexual characteristics of unusual interest. Several species, also, are of economic importance.

PYRALIDAE

GALLERIINAE

Trachylepidia fructicassiella Rag.—Bred from larvae found in pods of *Cassia fistula* in iv.

Mucialla rufivena Wlk.—Rare. Recorded in ii and viii.

Galleria mellonella L.—Imagines rare, larvae common in wild bees' nests. Recorded in i, x, xi and xii.

CRAMBINAE

Crambus atkinsoni Zell.—Uncommon. Recorded in x only.

Platytes argentisparsalis Hamps.—Rare. Records for x and xi.

Chilo suppressalis Wlk.—One in xi.

Ancylolomia chrysographella Koll.—Very common. Records for iii, vi, vii, ix, x and xi.

SCHOENOBIINAE

Ramila marginella Moore—Uncommon. Recorded in ix only.

R. acciusalis Wlk.—Uncommon. Records for viii only.

Scirpophaga auriflua Zell.—Very common. Recorded in vii, ix, x and xi.

S. gilviberbis Zell.—Not uncommon. Recorded in x only.

S. bisignata Swinh.—Not uncommon. Records for vii, x and xi.

Schoenobius immeritalis Wlk.—Common. Recorded in ii, vi, vii, x and xi.

S. bipunctifer Wlk.—Very common. Recorded in i, ii, and ix to xii.

S. adjurellus Wlk.—Common. Recorded in vii, x and xi.

S. incertellus Wlk.—Common. Records for ii, iii, x and xi.

Cirrhochrista brizoalis Wlk.—Common. Records for i to iii and vii to xi.

PHYCTINAE

Heterographella bengalella Rag.—Two in x.

Euzophera perticella Rag.—Uncommon. Recorded in i, v, ix and x.

Nephopteryx paurosema Meyr.—Common. Recorded in x, xi and xii.

N. leucophaeella Zell.—Common. Recorded in x and xi.

Epicrocis aegnusalis Wlk.—Common. Recorded in i, ii and ix to xii.

Myelois pectinicornella Hamps.—Bred from larvae found in pods of *Pongamia glabra* in i and ii.

Hypsipyla robusta Moore—Uncommon. Recorded in xi only.

Phycita hemixanthella Hamps.—Uncommon. Records for iii, vii, x and xi.

P. defiguralis Wlk.—Uncommon. Recorded in iv only.

Etiella zinckenella Treit.—Not common. Recorded in ii and xi.

EPIPASCHIINAE

Macalla carbonifera Meyr.—Bred in v and vi. Not in the Fauna.

Orthaga euadrusalis Wlk.—Uncommon. Records for ii, iii, x and xi.

ENDOTRICHINAE

Endotricha decessalis Wlk.—Uncommon. Recorded from viii to xi.

E. ruminalis Wlk.—Common. Recorded in vi, x and xi.

PYRALINAE

Hypsopygia mauritialis Bsd.—Not uncommon. Recorded in vii to xi.

Pyralis pictalis Curt.—Common. Recorded in ii, x and xii.

P. manihotalis Guen.—Common. Records for ii, iv, vi, viii and xii.

Stemmatophora pallidella Hamps.—Uncommon. Recorded in vi, ix and x.

Tamraca torridalis Led.—Rare. Recorded in ix only.

Herculia tenuis Btlr.—Rare. Recorded in vi only.

H. nigrivitta Wlk.—Not uncommon. Records for i, ii, iii, vii and x.

H. ignifluális Wlk.—Uncommon. Recorded in iii, vii and x.

H. suffusalis Wlk.—Common. Records for ii and vi to x.

HYDROCAMPINAE

Nymphula foedalis Guen.—Common. Recorded in viii to xi.

N. responsalis Wlk.—Common. Recorded in vi, ix and x.

N. crisonalis Wlk.—Common. Recorded in x and xi.

N. affinialis Guen.—Common. Recorded in i, x and xi.

N. fluctuosalis Zell.—Very common. Recorded in ii, ix, x and xi.

N. depunctalis Guen.—Common. Records for ix to xii.

Cataclysta fuscalis Hamps.—Not uncommon. Recorded in ix and xi.

Oligostigma bilineale Snell.—Common. Recorded in iii, x, xi and xii.

O. picale Guen.—Uncommon. Recorded in x and xi.

Talanga sexpunctalis Moore—Uncommon. Records for vii to xi.

Hymenoptychis sordida Zell.—Rare. Recorded in iii only.

Tatobotys varanesalis Wlk.—One only in vi.

Bradina admixtalis Wlk.—Very common, also in herbage. Recorded in ii, x and xi.

Hydrorybina bicolor Moore—Rare. Recorded in viii only.

Mabra eryxalis Wlk.—Rare. Recorded in x and xi.

PYRAUSTINAE

Pycnarmon virgatalis Moore—Uncommon. Recorded in x only.

P. caberalis Guen.—f. *abdicalis* Wlk. not uncommon. Recorded in ix, x, and xi.

P. meritalis Wlk.—Uncommon. Recorded in xi.

Zinckenia perspectalis Hbn.—Not uncommon. Recorded in ix, x and xi.

Z. **fascialis** Cr.—Very common. Larvae on garden Balsam. Records for all months except iv and v.

Eurrhyparodes tricoloralis Zell.—Uncommon. Recorded in x and xi.

E. **bracteolalis** Zell.—Fairly common. Recorded in ix and x.

Agrotera basinotata Hamps.—Common. Recorded in ix and x.

A. **scissalis** Wlk.—Uncommon. Recorded in iv and xi.

Pagyda traducalis Zell.—Common. Recorded in ix, x and xi.

Ercta ornatalis Dup.—Common. Records for ii, vi, vii, x, xi and xii.

Cnaphalocrocis medinalis Guen.—Very common. Recorded in i and ix to xii.

Marasmia venilialis Wlk.—Common. Recorded in i and ix to xii.

M. **trebiusalis** Wlk.—Common. Recorded in i, ii, x, xi and xii.

M. **trapezalis** Guen.—Common. Recorded in i, ii, and ix to xii.

Syngamia abruptalis Wlk.—Uncommon. Records for x and xii.

S. **floridalis** Zell.—Common. Records for ix, x and xi. Larvae on Urticaceae sp.

Bocchoris rotundalis Hamps.—Uncommon. Records for iii and v to xi.

B. **onychinalis** Guen.—Uncommon. Recorded in v, viii, ix and x.

B. **acamasalis** Wlk.—Not uncommon. Records for i, ix, x and xi.

B. **inspersalis** Zell.—Rare. Recorded in i and x.

B. **artificialis** Led.—Common. Recorded from vii to x.

Caprinia conchylalis Guen.—Not uncommon. Records for ix, x and xi.

Filodes fulvidorsalis Hbn.—In herbage, rare. Recorded in xi only.

Phryganodes analis Snell.—Uncommon. Larvae on *Cassia fistula.* Recorded in i, viii, x, xi and xii.

Dichocrocis evaxalis Wlk.—Fairly common. Recorded in v, vi and x.

D. **punctiferalis** Guen.—From larvae in seeds of Castor. Recorded in iv only.

Nacoleia diemenalis Guen.—Rare. Records for xi only.

Deba surrectalis Wlk.—One only in x.

Botyodes asialis Guen.—Common. Recorded from vi to x.

B. **flavibasalis** Moore—Not common. Recorded in i, vii and xii.

Sylepta derogata F.—Common. Larvae on Hollyhock and other Malvaceae. Recorded in iv, vi, ix, x and xi.

S. aurantiacalis Fisch.—Not common. Recorded in xi only.

S. lunalis Guen.—Common. Recorded from vii to xi.

Lygropia quaternalis Zell.—Fairly common. Records for iii, viii and x.

L. amyntusalis Wlk.—Fairly common. Recorded from vi to x.

Agathodes ostentalis Hbn.—Common. Recorded in vii, ix, x, and xi.

Glyphodes laticostalis Guen.—Uncommon. Recorded in i, iii and x.

G. negatalis Wlk.—Common. Recorded from i to v and in x, xi and xii.

G. psittacalis Hbn.—Uncommon. Recorded in x only.

G. hilaralis Wlk.—Common. Recorded from vii to xii.

G. marginata Hamps.—Rare. Recorded in viii only.

G. vertumnalis Guen.—Common. Larvae on *Tabernaemontana coronaria* (Apocynaceae). Recorded in i, iii and from vii to xii.

G. unionalis Hbn.—Uncommon. Larvae on Jasmine. Recorded in i, iii, viii, ix, xi and xii.

G. stolalis Guen.—Rare. Recorded in x only.

G. itysalis Wlk.—Rare. Recorded in vi, vii and xi.

G. bivitralis Guen.—Common. The male has an extrusible brush on either side of the prothorax; this is not mentioned in the Fauna. Larvae on Peepul. Records for i and vi to xii.

G. caesalis Wlk.—Common. Larvae on Peepul. Recorded for iii and from vii to xii.

G. canthusalis Wlk.—Fairly common. Larvae on Peepul. Records for ii, iii and from viii to xii.

G. bicolor Swains.—Common. Recorded from vii to xi.

G. indica Saund.—Common. Neither in India nor Africa have I ever seen a female. Recorded in i and from vi to xii.

Pygospila tyres Cr.—Common in some years, in others completely absent. Recorded in v, vi, vii and viii.

Euclasta defamatalis Wlk.—Rare. Recorded in iii, iv, vi and x.

Lepyrodes neptis Cr.—Common. Larvae on Jasmine. Records for vii to xii.

L. geometralis Guen.—Not common. Recorded in ix, x and xi.

Analyta sigulalis Guen.—Common. Recorded in i, ii and iii.

A. melanopalis Guen.—Common. Recorded in ii, iii, ix and x.

Leucinodes orbonalis Guen.—Common. Larvae in the fruits of various Solanaceae. Records for i, iv, and from vii to xi.

L. apicalis Hamps.—Not common. Recorded in ii, iv, ix, xi and xii.

Crocidolomia binotalis Zell.—Very common. Recorded in i, ii, iii, ix, x, xi and xii.

Sameodes cancellalis Zell.—Very common. Recorded in i and from vii to xii.

Archernis tropicalis Wlk.—One only in x.

Terastia meticulosalis Guen.—Uncommon. Recorded in iii, iv, vii, x and xi.

Omphisa anastomosalis Guen.—One only in vi.

Isocentris filalis Guen.—Fairly common. Recorded from vii to xi.

Crocidophora ptyophora Hamps.—Larvae on Bamboo, very common in some years, absent in others. Recorded in vi and from viii to xi.

Maruca testulalis Geyer.—Common, also in herbage. Recorded in i, ii, vi, x, xi and xii.

Tetridia caletoralis Wlk.—Uncommon. Records for iv, v and vii.

Pachynoa sabelialis Guen.—Common. Recorded in i, iv, ix, x, xi and xii.

P. pectinicornalis Guen.—Uncommon. Records for ii, v and xi.

Pachyzancla licarsisalis Wlk.—Very common, also in herbage. Recorded in i and from vi to xii.

P. phoeopteralis Guen.—Fairly common. Recorded in i, ix and x.

P. aegrotalis Zell.—Common. Recorded in ii, vii, ix and xi.

Phlyctaenodes massalis Wlk.—Rare. Recorded in iii only.

Diasemia ramburialis Dup.—Rare. Recorded in i, ii and x.

Antigastra catalaunalis Dup.—Very common. Recorded in i, v, ix, x, xi and xii.

Noorda blitealis Wlk.—Common. Recorded in iii, vi, vii, viii, x and xi.

N. fessalis Swinh.—Uncommon. Recorded in iv, v and vii.

Pionea albicostalis Swinh.—Rare. Recorded in ix only.

P. leucanalis Swinh.—Rare. Recorded in x and xii.

P. ablactalis Wlk.—Rare. Recorded in xii only.

Pyrausta phoenicealis Hbn.—Not uncommon. Recorded in vi, viii and x.

P. incoloralis Guen.—Uncommon, but larvae common on *Calotropis* sp. (Asclepiadaceae). Recorded in i, vi, vii, viii, x, xi and xii.

Concluded

VOICE AND LARYNX IN AFRICAN AND ASIATIC COLOBIDAE

BY

W. C. OSMAN HILL, M.D., F.R.S.E.,
Zoological Society of London

AND

A. H. BOOTH, B.A.,
Lecturer in Zoology, University College of Ghana

(*With 2 text-figures*)

SUMMARY

Laryngeal specialisation is a feature of the Primate family Colobidae. In an attempt to discover how far this may be correlated with vocal performance, extant field notes on voice have been summarised, and compared, so far as possible, with new material. The principal anatomical features of the larynges of seven genera are outlined.

Procolobus, in its alto utterances, associated with a small relatively unspecialised larynx, lacking saccules and accessory sacs, stands isolated from the other genera. On the other hand the larynx of *Colobus* (*sensu stricto*) is especially large, lacks an air-sac, but shares with its Asiatic congeners the deep resonant voice and the presence of a subhyoid sac and laryngeal saccules. *Presbytis*, while similar anatomically to its Asiatic congeners, emits a unique chuckling call; its larynx is very small. These preliminary results at once emphasise the close relationship of true *Colobus* to the Asiatic genera and the apartness of *Procolobus*.

INTRODUCTION

In a paper on the anatomy of the Olive Colobus Monkey (Hill, 1952) it was noted that details of the animal's utterances were not available, and that consequently laryngeal structure could not be interpreted in terms of function. The Olive Colobus is by no means unique in this respect; as we discovered during this investigation, the recording of details of mammalian voices is as yet in an unsatisfactory state. The family Colobidae are, however, of exceptional interest in their laryngeal anatomy, particularly with regard to the presence of accessory sacs in some members of the group. We have therefore collected all the available data on Colobid utterances, and examined preserved larynges of the following genera: *Colobus*, *Procolobus* (including *Piliocolobus*), *Semnopithecus*, *Kasi*, *Trachypithecus*, *Presbytis*, and *Nasalis*. The results for the Asiatic forms have been obtained from the collections and field notes of W. C. O. H., supplemented by data from the literature. The African forms have been investigated by A. H. B. in Ghana (the Gold Coast); anatomical notes were checked by W. C. O. H.

THE REPRESENTATION OF ANIMAL UTTERANCES

The problem of representing in print the vocal performances of animals is one to which little serious attention has been paid. Writers who mention animal utterances are apt each to choose his own method, and they generally record their observations in terms of the vowels and consonants of their own language. Confusion results from the lack of standardisation, as may be seen by reference to almost any book on the natural history of birds.

Adoption of the standard international phonetic symbols would seem to be an elementary step towards clarity and consistency. Even these, designed as they were to represent human phonation, are often far from adequate to denote the performance of a differently constructed larynx, still less that of a syrinx. Nevertheless, together with notes on pitch and quality, they can provide a much closer approximation than do the casual transcriptions so commonly published.

In recent years, conscientious ornithologists have attacked the common use of consonants in the transcription of bird calls, particularly the labial *p* which, for a bird, is an anatomical impossibility. The same sort of criticism is generally valid for representations of mammalian utterances, not so much in this case on anatomical grounds, but rather due to inaccurate observation or to misleading linguistic convention.

Such a conventional use of consonants has its roots in onomatopoeic names, which are common in every language. The same conventions sometimes apply in languages of very different structure. For example, *k* is used at the beginning of a syllable to indicate that the vowel immediately following begins at full volume, *m* that it begins softly, *ch* (tʃ) that it is harsh, and so on. *k* is also used to indicate a break between two syllables, as in the English 'cuc*k*oo'. Phonetically, the cry of the bird approximates to 'ʊ ʔ u: ', and it is best imitated by the human voice if the glottal stop is used as indicated between the two syllables. Certainly the consonantal *k* is incorrect. An exactly analogous case is the Ashanti onomatopoeic name for the monkey *Cercopithecus lowei*: the root of the name is ' kwaku ', the cry ' a ʔ u: '.

Consonants used in this way will here be called *indicator consonants.* The main disadvantage of their use in describing the utterances of a monkey lies in the fact that the animal may indeed be capable of producing genuine consonants. If an observer in recording a call uses indicator consonants, it is impossible to tell, without further information, whether consonants are uttered or not.

In this paper, we have necessarily admitted indicator consonants where the data are drawn from the literature, or where our field notes had been taken before the phonetic transcription had been contemplated. But wherever possible, the cries of the monkeys are recorded first phonetically, with notes on pitch, volume, and quality, and then in English transcription, using indicator consonants.

THE VOICES OF COLOBIDAE

Our knowledge of Colobid utterances suffers from the fact that these monkeys, and more particularly the African forms, are exceedingly difficult to keep in captivity; and, whilst it is an admittedly important principle that all calls heard in captivity should be checked against field records, the captive specimen is a most useful subject. Not only does it enable the transcription of the call to be checked, but it also gives what is apt to be all too rare in the field, a view of the animal during phonation, unimpeded by the forest foliage or by the necessity for concealment.

Colobus polykomos. This species has been studied as representing the Black Colobus *Formenkreis.* No differences have been observed between the calls of the three subspecies *polykomos*, *dollmani*, and *vellerosus*. The voice is at once distinguished from those of the Red and of the Olive Colobus (genus *Procolobus*) by its deep pitch and great resonance.

The full call of the Black Colobus is characteristically uttered by the male. It may easily be represented phonetically as 'ə: ə: ə: ə:'. About five to ten syllables are normally uttered, the full duration of the call being about seven to fifteen seconds. There is a distinct rise in pitch and volume both within each syllable and throughout the call as a whole. Beginning about 2½ octaves below Middle C, each syllable represents a rise of something over a semitone in pitch. In quality, the call resembles a human bass voice straining below the lowest pitch in its register, but it has the great resonance noted above, which prevents its being called a 'grunt'. Even within the closed forest, the call can be heard from a great distance. A suitable English rendering would be 'rurr rurr rurr rurr'. The full call would seem to have the same sort of significance as in monkeys and apes in general. Usually, if not invariably, uttered by an adult male, it may be heard in the absence of any apparent external stimulus. In such cases it may be interpreted as an assertion of status by the overlord of a troop. It is, however, also used in defiance, particularly in the presence of the Crowned Hawk-Eagle, *Stephanoaëtus coronatus.* Similar behaviour on the part of a mangabey *Cercocebus albigena* has been recorded by Malbrant and Maclatchy (1949).

The alarm-call, which may precede the full call uttered in defiance but is more often heard alone, is common to all ages above the infant, and to both sexes. It takes the form of an explosive snort, uttered partly through the nose. Phonetically it approximates to 'tnɪ'.

These two cries might be considered to be the only fully social utterances of the Black Colobus. The remainder are of a more intimate nature, having significance apparently either to the utterer alone, or to its immediate neighbour (mother, offspring, rival, etc.).

When mortally wounded, the Black Colobus utters isolated, resonant croaks, similar to the syllables of the full call. This observation applies to adults of both sexes.

Occasionally, when the observer is within a very few yards of an unsuspecting troop, a very soft grunting may be heard. This call has about the same initial pitch as the full call, but lacks both the resonance and the rise in pitch when repeated. It is easily confused with a similar sound of different significance uttered by the male of *Cercopithecus petaurista.* Only one specimen has been shot while making the call. This was a lactating female. Though apparently intimate, the call has not been heard in captivity.

The only other adult call recorded consists of a series of snorts uttered at about ½-second intervals. These are quite irreproducible in print, but recall the noise made by a pig excitedly rooting. In the field, the call has only been heard when two individuals quarrel, or when a wounded specimen on the ground is approached. In captivity, it is the call most frequently uttered, both by adult and subadult specimens down to about one year old. It seems to indicate any kind of excitement, not necessarily anger or defiance. It can be imitated to good effect by hunters, who thereby induce the monkeys to show themselves, apparently in curiosity.

The calls of the young Black Colobus are not detailed here. They include a variety of screams and other intimate and often pathetic noises. The ability to grunt at a very low pitch is acquired within a few months of birth.

Procolobus (Piliocolobus) badius. The two races *P. b. badius* and *P. b. waldroni* have been studied; they have closely similar vocal capabilities, and the species is notable for its apparent inability to remain silent for any length of time. Often uttered from the tops of the highest trees, its monosyllabic call is very bird-like when heard from a distance. At closer range, however, it has a much more human quality.

The basic call, from which all the others are apparently derived is ‘jaʊʔ’, pitched in the octave below Middle C. An English version with indicator consonants would be ‘kyowp’. (Natives of Guiglo, Ivory Coast, nickname the species ‘kyow-kyow’). All the variants of this basic call can be imitated with great accuracy and without strain by the human female.

The basic call is uttered most frequently, most loudly, and at its highest pitch in the presence of an intruder, whether human or animal. Even under comparatively peaceful circumstances, however, the effort put into the act of phonation is considerable. The vocal individual can, indeed, be identified at a distance by the shaking of the surrounding vegetation.

When a fight is in progress, the combatants’ utterances may become more abrupt and ferocious or (perhaps in the case of the loser) more drawn-out and feline. In the latter case, the glottal stop is absent thus: ‘iau:’. The English version of this call is ‘yow’.

An utterance less frequently heard is a simple ‘aʊ’ (English ‘ow’). The quality and pitch of this sound are those of the human female at a rather low point in her register. It is neither very emphatic nor very loud, and is often interspersed in a series of loud ‘kyowp’ calls, as if the utterer were exhausted by the effort. The only two specimens obtained while uttering this call were adult males.

The last variant of the basic call is very rarely heard. Our two field records appear to suggest that it is part of a deliberate act of defiance by the overlord male of a troop. In both cases the troop had been pursued without shooting, in an attempt to isolate the nursing mothers. After a considerable distance had been covered, the dominant male abandoned the upper canopy and descended to within one hundred feet of the ground, pacing up and down in an agitated manner and constantly looking down at the hunters. The cry uttered was a fierce and at the same time drawn-out variant of the basic call, something between a howl and a bark in quality.

The Red Colobus is both unusual and limited in its vocal range. Although the adult calls do apparently include expressions of alarm, defiance and more casual intercommunication, they are all variants of a single simple utterance. The cries of infant and juvenile stages have not been studied in detail, as such specimens rarely survive more than a few days in captivity, while the volume of the cries is so feeble that in the field they can only with difficulty be heard at all. It is interesting to note, however, that a distinct consonant has been heard in one of the calls of the infant Red Colobus. The call is a bird-like ' tju ' or ' tjaʊ '. In view of this observation at close range, it must be regarded as possible that the consonant is also used by adult monkeys on some occasions, but remains undistinguished at treetop height.

Procolobus verus is but poorly known ecologically and ethologically. The opportunity is here taken of modifying certain impressions of its habits which were reported in the earlier paper (Hill, 1952). In Ghana and Ivory Coast, the species appears to be neither rare, omnivorous, nor solitary. It is, however, both shy and silent, alike in its progress through the thick undergrowth and in its reluctance to use its voice. It lives in parties of from 5 to 20 individuals, which are most frequently to be found feeding in company with the much noisier Cercopitheci, *C. mona*, *C. campbelli*, or *C. petaurista*. Communal feeding does not imply a common diet, since the Olive Colobus remains true to type in eating only leaves. The above remarks will be expanded elsewhere, but for the present purpose they serve to explain the paucity of observations and the remarkably limited use of the voice.

Apart from screams of terror, the only call of this species which can be regarded as satisfactorily recorded is a truly remarkable utterance. The call is 'u: u: u: u: ɪaʊ ɪaʊ ui: ui: ɪaʊ'. It rises steeply in pitch and volume to the penultimate syllable, and dies away on the last. In English it may be rendered 'hoo hoo hoo hoo yow yow wee wee yow'. The call may be complete, or only a part of it may be uttered. In neither case is its significance clear. Like the calls of the Red Colobus, it is alto in pitch and almost human in quality until the climax, when it degenerates into a scream. The whole effect is more like the cry of a Chimpanzee than that of a monkey, especially when several members of the troop are calling at the same time. The relationship to the call of the Red Colobus is, however, clearly audible in the ' yow ' syllable, which is, very rarely, uttered alone.

No definite alarm call has been heard from this species, even when a troop has been surprised in the absence of Cercopitheci. There is little doubt that the silence of the Olive Colobus is correlated with its frequent association with these Guenons. The latter, being largely fruit-eaters, are of a much more active and inquisitive disposition when feeding, and are almost invariably the first to spot an intruder. Their alarm calls are, moreover, apparently understood and acted upon by the Olive Colobus. This behaviour is in contrast to that of the Red Colobus, which, feeding generally at a much greater height, is normally seen to disregard the activities and utterances of the Cercopitheci, and sometimes even those of the Black Colobus.

The most striking feature of the calls of the African Colobidae as a group is their lack of close and obvious interrelationships. The Black Colobus especially is widely separated from its relatives.

As between Cercopitheci, by contrast, there is a very distinct common pattern to the vocal performances of the various species. This has been remarked upon by Haddow (1952). In West Africa, for example the calls of *C. mona* and *C. campbelli* are, though interdistinguishable, closely related. *C. petaurista* is a little more distant, and *C. diana* still more so. *C. aethiops* is altogether harsher, and lacks any musical notes. *Erythrocebus patas* is still recognisably *Cercopithecus*-like. But between the Guenons and the Mangabeys (*Cercocebus* spp.) there is virtually no comparison.

Of the Colobus monkeys, it is clear that the Olive and the Red species are least different in their vocal range. The degree of difference is hard, to judge, but if a comparison with the Guenons may be taken as a guide the difference between the calls of the Olive and the Red Colobus is at least equal to that between the calls of *Erythrocebus* and of any *Cercopithecus* sp. From both the Red and the Olive Colobus the Black Colobus is separated by a gap at least as wide as that between *Cercopithecus* spp. and *Cercocebus* spp.

Semnopithecus entellus. Considering Blanford's remark (1888) that 'Few, if any, wild animals afford better opportunities for observation than the Hanuman Monkey', there is very little information about its voice. The same author goes on to describe two calls. The first is 'a joyous, musical "whoop" uttered in motion, used chiefly at dawn and dusk,' and the second 'a harsh, guttural alarm-note'. Stripping the former call of its indicator consonants, it may well correspond to the full call of the Black Colobus, though the African species has never been observed to utter the full call in motion.

Semnopithecus schistaceus. 'The call is "hoop, hoop", generally uttered as a warning cry by one of the troop', Pocock (1939). This cry is doubtless almost identical with that of the Hanuman recorded above.

Semnopithecus priam. The voice of the male of this species is a deep 'u: ', several times repeated. In English this may be written 'boom'. Each syllable is of longer duration than in the rather similar call of *Kasi senex*. In quality, the note is like the bay of a foxhound, but the pitch is rather higher. There is also a conversational whine, used more by females and juveniles.

Kasi johnii. Blanford describes this species as very noisy, having a long loud full call and a low, guttural alarm call, used also in anger. Kinloch (1923) gives the full call, as 'hoo-ha hoo-ha hoo', uttered at any time of the day. As already noted (Hill, 1937), the roaring full call is like that of *K. senex monticola*. The double 'hoo-ha' recorded by Kinloch appears to be one of the effects of great resonance of the voice; phonetically it approximates to 'uəa:'. There is also a short, sharp growl, probably the alarm call noted by Blanford, and a whining note used by females and juveniles.

Kasi senex. Phillips (1935) gives the call of the male as 'hooh hooh hooh.' He also reports a shrill squeak indicating curiosity, and a bird-like twitter expressing pleasure or excitement. W.C.O.H. has confirmed these observations. The male full call is deeper, more throaty and more sharply cut off than in *Semnopithecus* spp. It is seldom heard in captivity, though the squeak and twitter are frequently used.

Trachypithecus pileatus. McCann (1933) mentions a harsh bark, interpreted as an alarm call, and a squeaking noise.

Trachypithecus phayrei crepusculus. Tickell (MS), quoted by Blanford, states that the short, deep bark of this monkey resembles that of *Semnopithecus entellus.*

Trachypithecus obscurus. The voice is similar to that of *Kasi senex.* There are two versions of the alarm-call. The shorter is a sharp 'tnɑʔ', English 'chāk'. At other times a disyllabic call is used thus: 'tnɑʔɔː' English 'cha-hau'.

Trachypithecus cristatus. Banks (1931) notes that a young captive specimen of the typical race uttered plaintive, gibbon-like squeaks. The alarm-call of *T. c. pyrrhus* is given by van Balen (n. d.) as 'ki cha hau' (Dutch). Forbes (1897) quotes onomatopoeic native names collected by Hose as follows: Dyak – 'bigok'; Kayan – 'chikok'. These are clearly versions of the alarm call which seems to be characteristic of the genus.

Presbytis femoralis. van Balen gives the native name as 'gyak-gyak', which is presumably an imitation of the alarm call. Banks likens the noisy staccato chuckle of *P. f. chrysomelas* to that of a giant squirrel (presumably *Ratufa bicolor*).

Presbytis melalophos. van Balen transcribes the cry as 'kjèk kjèk kjèk kjèèèk kjèèèk kjèk kjik kijk' (Dutch).

Presbytis frontatus, P. hosei, P. everetti. Banks finds the 'loud chuckles' similar to that of *P. femoralis*, but notes also that *P. hosei* and *P. everetti* utter a snorting sound similar to that of *Nasalis.*

Presbytis rubicundus. This species has a scolding, truculent cry, and, according to Banks, another call which is a series of loud, resonant chuckles; the first note of the latter is as in *P. f. chrysomelas*, the succeeding four sharper and shriller.

Nasalis larvatus. Hornaday (quoted by Forbes, 1897) gives the cry of the Proboscis monkey, presumably the full male call, as 'honk' or 'kec-honk'. Shelford (1916) refers to it as a 'sort of snorting bark' and believes that the fleshy nose plays a part in its production. Banks states that anger is expressed by a loud, resonant snore uttered with opened mouth. He also remarks that inhalation and exhalation through the nose are audible at some distance. The female has a petulant cry, faintly resembling that of a goose.

Comments on Voice

Despite the heterogeneity of the above observations, certain patterns of vocal capabilities emerge. Firstly there is the undoubtedly aberrant performance of *Procolobus verus.* The restriction of the utterances of this species to alto and treble pitch even in adult males is especially noteworthy. There is no evidence of the typical bark or even a snort.

What we have referred to as the full call, emitted typically by the dominant male, would seem to have a common pattern in *Colobus*, *Semnopithecus*, *Kasi*, and *Trachypithecus.* This consists of a series of simple repeated syllables of great resonance. The generally monosyllabic alarm call is also rather closely similar in all these genera, and probably *Nasalis* falls in here, though data are at present insufficient relative to this genus.

Presbytis appears to be unique in its ability to produce a chuckling sound. Such calls are common in mangabeys and macaques, but have not been recorded in any other Colobid genus.

The squeaks and screams recorded at various points in the account are, of course, common to all young monkeys. But the twittering sound reported in *Kasi* appears to be peculiar to that genus.

LARYNGEAL ANATOMY

This account of the comparative anatomy of the Colobid larynx is largely supplementary to that already given elsewhere (Hill, 1952).

Dimensions. The measurements given in Table I reveal that *Colobus polykomos* possesses by far the largest larynx of those measured (the size is equal to that of an adult human male). At the other end of the scale, *Procolobus verus* and *Presbytis femoralis* both have very small larynges. *Procolobus badius* has a slightly larger one, but the organ is still distinctly inferior in size to those of the remaining Asiatic genera, which are remarkably uniform in this respect.

TABLE I

Dimensions of Colobid larynges. Adult Males.

		Length	Diameter	
			Dorsoventral	Transverse
		mm.	mm.	mm.
Colobus polykomos vellerosus	...	59	36	34
Semnopithecus priam	...	36	23	21
Kasi s. senex	...	39	20	20
Trachypithecus obscurus	...	35	21	21
Presbytis thomasi	...	16	13	12
Nasalis larvatus	...	36	20	24
Procolobus verus	...	20	12	14
Procolobus badius waldroni	...	24	16	15

The hyoid apparatus. Throughout the Colobidae, the corpus hyoidei has the shield-like shape common to all Catarrhine monkeys. This shape is generally associated with the presence of some kind of subhyoid sac opening into the larynx at the base of the epiglottis. The convexity of the shield is disposed antero-ventrally, its concavity towards the vestibulum laryngis (Fig. 1B). Despite the absence of a subhyoid sac in the genus *Procolobus*, the shield-shaped corpus hyoidei persists; the bone is, however, of relatively solid structure.

The anterior cartilages. The epiglottis is broad in all Asiatic genera and in *Colobus*. As already noted (Hill,1952), it is relatively broader in *Procolobus verus* than in *P. badius*, but in both species it narrows appreciably towards the tip. In all genera, it is placed at a pronounced angle to the axis of the thyroid cartilage; this angle is often almost a right angle, but its variability is doubtless in part due to the process of

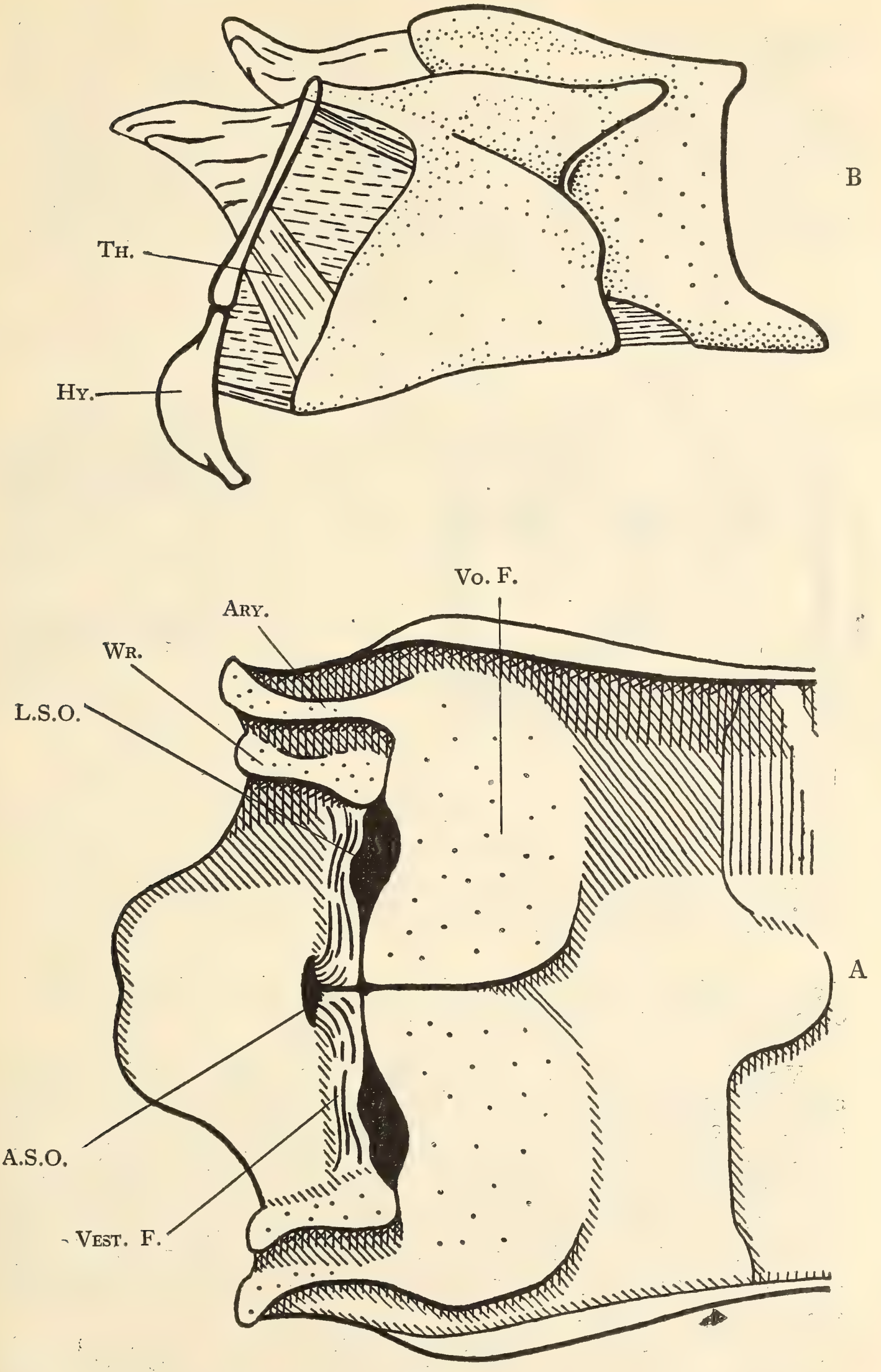


Fig. 1.

Colobus polykomos vellerosus

Larynx of the adult male,
A: opened by a median dorsal incision to show internal features; B: in left lateral view
Ary = Arytenoid cartilage; A. S. O. = Air-sac opening; Hy = Corpus hyoidei; L.S.O. = Opening of laryngeal saccule; Th. = Oblique thickening of thyro-hyoid membrane; Vest. F. = Vestibular fold; Vo. F. = Vocal fold; Wr. = Wrisberg's cartilage.

fixation. The epiglottis thus forms an almost complete, mobile roof to the vestibule.

The free margin of the epiglottis is entire in *Semnopithecus*, *Kasi*, and *Presbytis melalophos*, slightly notched in some specimens of *Trachypithecus obscurus* and of *Procolobus*, and distinctly notched in *Nasalis*. In *Colobus* and in *Presbytis thomasi* there is a broad, shallow depression at the tip.

Wrisberg's cartilages are markedly swollen in all the forms investigated, with the sole exception of *Procolobus badius*. In this species, they hardly project from the aryepiglottic fold (Fig. 2). Of the remaining forms they are perhaps least developed in *Kasi* and *Trachypithecus*, though even here they are unusually prominent.

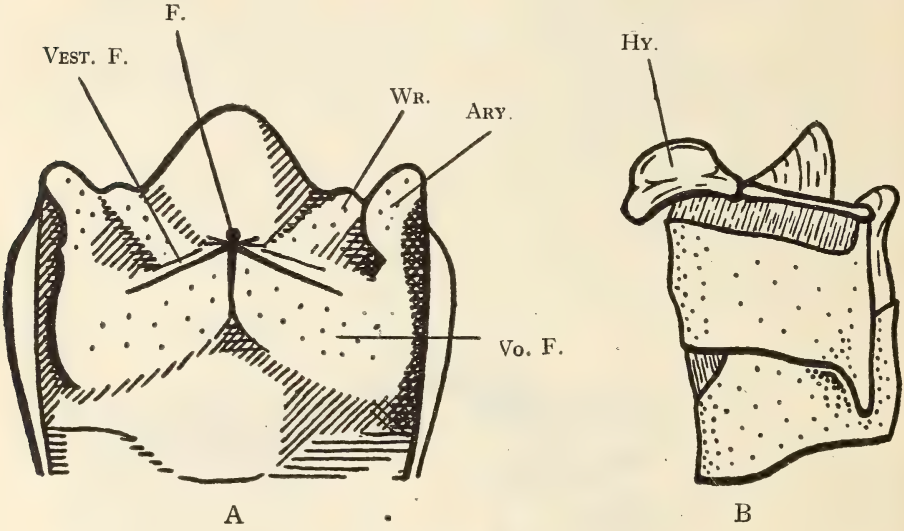


FIG. 2.

Procolobus(Piliocolobus) badius waldroni.

Larynx of the adult male drawn as the corresponding views in fig. 1.
F. = blind fossa in position of air-sac opening.
Other references as in fig. 1.

Vestibular folds. These organs are usually well defined, especially towards the mid-ventral line, where they are sharply demarcated. They are, however, inclined to be feeble in *Presbytis thomasi* and in *P. melalophos*. In *Colobus* the vestibular folds are blunt-edged, having a loose, fleshy appearance (Fig. 1A). The ventral (median) extremities of the vestibular folds of the two sides are separated in all Asiatic genera by the opening of the subhyoid sac. In *Colobus*, the extremities of the vestibular folds are continued into the walls of the sac. In *Procolobus*, where the sac is absent, a blind fossa in the same morphological position separates the folds (Fig. 2A).

The main part of the opening of the subhyoid sac is more or less slit-shaped in *Presbytis*. In *Semnopithecus*, *Kasi*, *Trachypithecus*, *Nasalis*, and *Colobus* (Fig. 1A), there is at the anterior end of the median slit a transverse extension, giving the opening a T shape. The transverse limb of the T effectively defines the cranial border of the vestibular folds, hence the feeble definition of these folds in *Presbytis.*

Subhyoid sac and air sac. In all Asiatic genera studied, both these structures are present. The subhyoid sac opens into the larynx by the generally T-shaped opening described above. It then expands to a capacity of some few millilitres beneath the concavity of the corpus hyoidei. Its expansion is limited particularly by the oblique ligamentous thickenings of the thyrohyoid membrane (Fig. 1B), and by the corpus hyoidei itself. *Colobus* resembles the Asiatic genera in this respect.

In the Asiatic genera the subhyoid sac ventrally takes a turn caudad as funnel-like passage, piercing the thyrohyoid membrane and deviating to the right to bypass the stratum of the infrahyoid muscles. Thereafter, it expands in the subcutaneous areolar tissue to form the main portion of the air sac, which extends over the base of the neck to the clavicular region, and anteriorly as a saccule in the interramal region. In a female of *Kasi senex nestor*, a cast of the uninflated air-sac displaced 35 ml. In life, the sac is capable of much greater inflation, standing out as a goitrous body in the neck. Inflation and deflation are possible without accompanying phonation. The platysma myoides overlies the sac superficially and doubtless serves to deflate the organ.

In *Colobus*, the subhyoid sac is not continued into an air sac, the thyrohyoid membrane being nowhere pierced. In *Procolobus*, there is no subhyoid sac. The blind fossa noted above doubtless represents a vestigial subhyoid sac, which has become reduced simultaneously with the larynx as a whole.

Laryngeal saccules. These structures are blind, inextensile upgrowths of the ventricle, which resemble those of the human larynx. They do not become extra-laryngeal as in Apes, but they are relatively larger than those in Man, except in *Procolobus*, where they are very much reduced. The openings of the laryngeal saccules, bounded by the vocal and vestibular folds, are narrow and slit-like in the Asiatic genera, and extremely so in *Procolobus*. In *Colobus*, they are quite broad and irregular in shape (Fig. 1A).

Vocal folds. *Colobus* is unique in possessing vocal folds with a blunt, curved anterior edge. In the Asiatic genera, the vocal folds are straight and sharp-edged, as in *Procolobus*.

In laryngeal anatomy, as in voice, the genus *Procolobus* in many respects stands isolated from *Colobus* and from the Leaf-monkeys of Asia. The reduction of the subhyoid sac and of the laryngeal saccules are the chief points of difference. *Colobus* is intermediate between the Leaf-monkeys and *Procolobus* in one particular, namely the presence of the subhyoid sac without its extension into an air-sac. In the structure of its vocal and vestibular folds, however, it conforms to neither group, and must be considered aberrant.

DISCUSSION

It is evident that at this stage laryngeal structure and voice can only in the most general terms be correlated.

1. Size of larynx. The expected relationship between physical dimensions and depth of voice appears to hold good. In this respect there are three distinct groups.

a. Colobus. Larynx very large. Voice extremely deep.

b. Semnopithecus, Kasi, Trachypithecus, Nasalis. Larynx large. Voice deep, but not, apparently, as deep as *Colobus.*

c. Presbytis, Procolobus. Larynx small. Voice staccato, rather high pitched (*Presbytis*) or distinctly alto (*Procolobus*).

2. Subhyoid sac. The voices of all those genera possessing the subhyoid sac are described as 'resonant' by most observers. This observation is of particular interest in the case of *Presbytis*, in view of the small size of its larynx.

3. Air-sac. Negus (1949, p. 56) concludes that 'there is little evidence to support, but much to disprove, the generally accepted view that air-sacs are developed for the purpose of voice'. He suggests that the significance of practically all air-sacs (including the subhyoid sacs mentioned above) is that they enable air to be conserved during periods of intense activity, when it is not possible to bring into action the normal muscles of inspiration and expiration. Any vocal function they may perform is held to be purely secondary. This view is worthy of some discussion, since Negus's work is the most comprehensive on the subject of comparative laryngeal anatomy.

Since there is no muscular mechanism by which the air sac can be filled directly from the ambient atmosphere, the air with which it is inflated must come from the lungs. This is doubtless achieved by the following stages: (1) air is drawn into the lungs; (2) the oral and nasal passages are closed; (3) the lungs are emptied by a normal expiratory movement, and the air thereby forced into the air sac. The process may be repeated until the sac is fully distended. Finally, the lungs may be inflated in addition. The animal would then be ready, according to Negus's theory, to undertake a bout of strenuous activity.

There are, however, several objections to the above suggestion as to the function of the air-sac. In the first place, the sac will inevitably contain only expired air, with a relatively low oxygen and high carbon dioxide content. Secondly, if the normal respiratory movements are to be avoided during the period of intense activity, the only possible means of passing air between air-sac and lungs is the very slow process of mixing by diffusion, rendered even slower by anatomical considerations. It would be possible for the monkey without impairing its activity to perform a normal expiratory movement, and then perhaps to reinflate the lungs by deflating the air-sac. But since the mechanism for deflation is merely the weak platysma myoides, it is doubtful if there is any real support for this suggestion. Lastly, there is no indication that *Colobus* and *Procolobus*, which lack air sacs, are any less capable of violent or sustained activity than are the Leaf-monkeys. We therefore consider that the explanation of Negus as to the primary function of the air-sacs is unsatisfactory.

On the other hand, it is almost certain that any vocal significance which the air-sac may have is secondary. The position of the opening is such that only if air is breathed *in* from the sac will it pass over the vocal folds on its way out to the atmosphere. Air passing out directly through the nose or mouth cannot itself be responsible for phonation, though it may modify the sound produced by air passing out from the lungs over the vocal folds in the normal way. In addition, the inflated air-sac almost certainly affects the resonance of Leaf–monkey utterances.

It has been remarked above that the air-sac is capable of inflation and deflation without any accompanying phonation. The performance has a marked effect on the appearance of the animal. It is thought likely that the action may have some social significance, and that this significance may be the primitive one.

On the other hand, the subhyoid sac, as noted above, would appear to be purely vocal in function. The resonance of the calls of the Asiatic genera might perhaps have been ascribed to the presence of the air-sac alone. But the air-sac is absent in *Colobus*, while the resonance of the call remains very great. The case cannot be regarded as proved, since the larynx of *Colobus* is exceptionally large, and would have resonance in its own right. No other possible function, however, suggests itself at present.

ACKNOWLEDGMENTS

The field work in West Africa was supported by a grant (to A. H. B.) from the Academic Board of the University College, Ghana. A. H. B. is also indebted to Professor E. E. Edwards of the same institution for facilities of various kinds.

Observations on the Leaf-monkeys, where not culled from earlier literature are based on the field notes of W. C. O. H., and correlated with later laboratory studies on material personally collected in India and Ceylon, supplemented with specimens generously donated by Mr. W. J. C. Frost to whom our thanks are due.

REFERENCE

van Balen, J. H., n.d. *Dierenwereld van Insulinde*. I *De Zoogdieren*. Zutphen, W. J. Thieme & Cie.

Banks, E. (1931) : "A popular account of the Mammals of Borneo". *J. Malayan Br. Asiat. Soc.*, **9** (2) : 1–139.

Blanford, W. T. (1888) : Fauna of British India. Mammals. London, Taylor & Francis.

Forbes, H. O. (1897) : A Handbook of the Primates. Vol. II. London, Edward Lloyd.

Haddow, A. J. (1952) : Field and laboratory studies on an African monkey, *Cercopithecus ascanius schmidti* Matschie, *Proc. Zool. Soc. Lond.*, **122** : 297–394.

Hill, W. C. Osman (1937) : The Primates of Travancore, *Proc. Zool. Soc. Lond.*, **107** B : 205–216.

— — — — — (1952) : The external and visceral anatomy of the Olive Colobus Monkey (*Procolobus verus*) *Proc. Zool. Soc. Lond.* **122** : 127–186.

Kinloch, A. P., (1923) : The larger Mammals of the Nelliampathy Hills, *JBNHS*, **29**, 552–554.

McCann, C., (1933) : Observations on some of the Indian Langurs (*Pithecus*) . *JBNHS*, **36** : 618–628.

Malbrant, R., and Maclatchy, A. (1949) : Faune de l' Equateur African francais, II. Mammiféres. *Encycl. Biol.*, **36** : 1–323.

Negus, V. E. (1949) : The Comparative Anatomy and Physiology of the Larynx, London, Heinemann.

Phillips, W. W. A. (1935) : Manual of the Mammals of Ceylon, Colombo, Colombo Museum.

Pocock, R. I. (1939): Fauna of British India, Mammals, 2 ed., vol. 1, London, Taylor and Francis.

Shelford, R. W. C. (1916) : A Naturalist in Borneo, London, T. Fisher Unwin, p. 13.

ON A ZOOLOGICAL COLLECTING TOUR OF THE ISLANDS OFF JAFFNA *

BY

P. H. D. H. DE SILVA,

Assistant in Zoology, National Museums, Ceylon

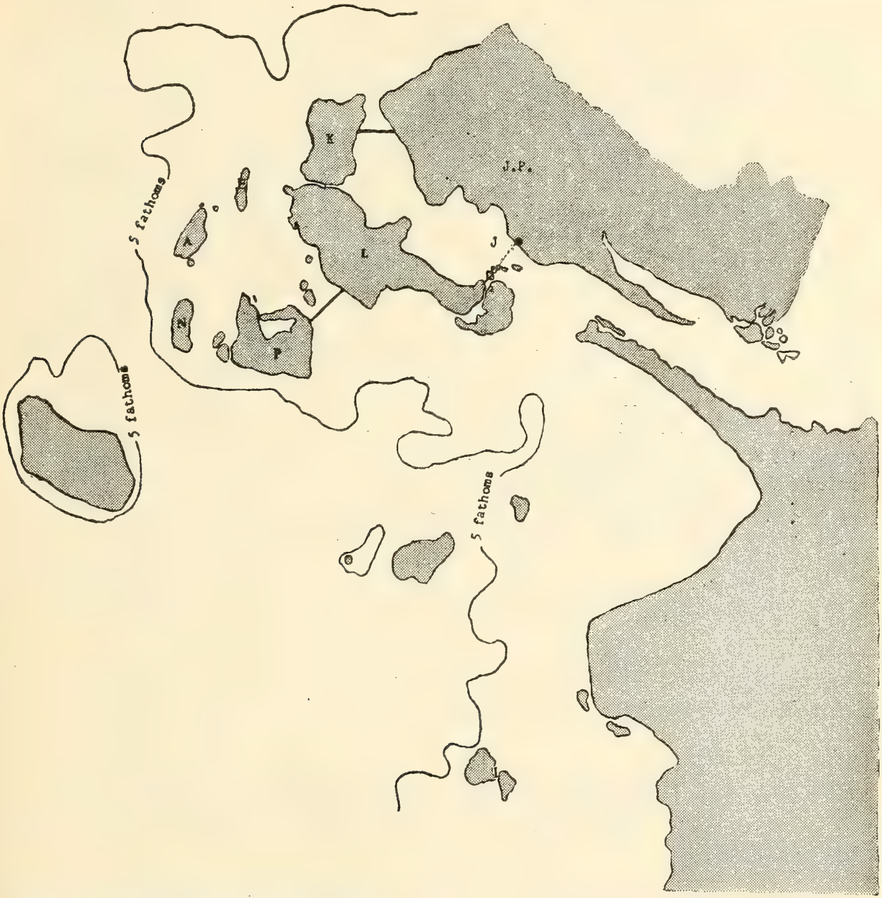
(*With a map*)

Lying to the west and south-west of Jaffna is a group of eight islands, namely Karaitivu, Leyden, Mandaitivu, Punkudutivu, Eluvativu, Analativu, Nainativu, and Delft. Although a number of collecting tours had been undertaken from time to time to the island of Iranétivu, which lies about 12 miles to the south of Jaffna as the crow flies, no attention has been focussed on the fauna of the islands off Jaffna. It was decided, therefore, to make a preliminary survey of the fauna of these islands, and a tour of three weeks' duration was commenced during the second week of February this year (1956). Little attention was paid to the collection of marine fishes, but great emphasis was placed upon the collection of freshwater and land forms.

The islands closest to the mainland of Ceylon are Karaitivu, Leyden, and Mandaitivu, the first of which is Karaitivu. *Karaitivu* is situated at a distance of nearly two miles from the mainland and is almost nearly rectangular in shape. It measures nearly 4½ miles in length and about three miles in width at its broadest region. It is much narrower at the middle. A two-mile causeway, the Punalai Causeway, connects it with the Jaffna Peninsula, whilst by ferry with the island of Leyden at Kayts. In the grey loamy soil region of the central, southern, and north-western areas paddy is cultivated, whilst palmyrah abound in the remaining sandy tracts of the island. The north-eastern and eastern shores of the island show patches of open country and marsh. The Island of *Leyden* lies nearly parallel to the western and south-western coasts of the Jaffna Peninsula. It is longer than broad, being nearly 15 miles in length and nearly 4½ miles in breadth. It is connected with Karaitivu by ferry at Kayts and with Jaffna by ferry and causeway. Paddy cultivation is mainly centred in the grey loams of the central and northern areas of the island. The rest is sandy with sand dunes along the western shore, and open country on the eastern margin of the island. In the sand dune area palmyrah predominate, being replaced by thorny scrub and cacti in the open country. *Mandaitivu* is a comparatively small island lying at the southern extremity of the island of Leyden and connected to the latter by road. In some areas the soil is of the reddish variety, where tobacco cultivation is practised. The rest of the island is practically unsuitable for any cultivation. Both palmyrah and coco-nut are grown. The island of *Punkudutivu* is nearly square-shaped, lying to the south-west of Leyden and nearly 4 miles in length and about 3½ miles in breadth. To its west lies the island of Nainativu and to its north-west the island of Eluvativu. Paddy cultivation is extensively practised in the grey loamy soil region, being replaced by the cultivation of cereals and palmyrah in the remaining sandy area. The northern shore is mainly open country, whilst there is a large area of marsh on the eastern shore. Punkudutivu is connected by a 2½ mile causeway with the island of Leyden. At its south-western margin are two other small islands, Naduturitti and Kurikaduvan, the former being practically all marshy. *Eluvativu*, is a small island lying to the west of Kayts, at a distance of about 3½ miles from Kayts as the crow flies. It is much longer than broad,

---

* Published with the permission of the Director, National Museums, Ceylon.



Scale: Quarter-inch = *ca.* 2.5 miles.

Map to show the Islands off Jaffna.

J. P. = Jaffna Peninsula. K. = Karaitivu. L. = Leyden M. = Mandaitivu. E. = Eluvativu. A. = Analativu. N. = Nainativu. D. = Delft. I. = Iranétivu. J. = Jaffna.

being nearly two miles in length and less than a half a mile in width at its widest region. It is entirely sandy with no cultivation either of paddy or cereals except for a tiny patch at its southern end. The whole island abounds in palmyrah. The water in the few wells of the island is brackish and at the time of my visit the inhabitants were draining water from shallow pits dug on the shore. I was also informed that by the beginning of April water has to be brought to the island from Kayts. *Analativu* lies to the south-west of Eluvativu and is much longer, being nearly 2½ miles in length and nearly a mile in breadth. Paddy cultivation is centred around the grey loamy soils of the central region of the island, whilst the sandy areas abound in palmyrah. Tracts of open country fringe the northern, southern, and western shores. Wells contain freshwater and at the time of my visit there were a large number of freshwater ponds and ditches. Between Eluvativu and Analativu is a small uninhabited island of low scrub. At the southern end of Analativu is another small island, *Puliantivu*. *Nainativu* is another small island, nearly 2½ miles in length and about a mile in breadth. It lies to the west of Punkudutivu and at a distance of nearly 11 miles from Kayts as the crow flies. Paddy and tobacco cultivation is practised in the central region of the island, whilst the rest of the island is sandy. The western shore is open country. Freshwater wells and freshwater pools and ditches are found. There is also pipe-borne water along the main road from the Jetty. *Delft* is the furthermost of the eight islands, and lies to the south-west of Nainativu, and Punkudutivu, about 16 miles from Kayts as the crow flies. It is nearly 5½ miles from the island of Nainativu. It measures nearly 7 miles in length and about 3¾ miles in breadth at its widest region. It is perfectly flat. Paddy cultivation is practised in the western portion of the island, whilst in the remaining areas cereals are cultivated. In the northern part palmyrahs predominate, whilst the southern region is open country with low trees and scrub in the south-eastern area and open plains nearly surfaced with coral stones. Except for the lagoon no pools or ditches were seen at the time of my visit. Well water is brackish. The extent of the island is nearly 18 sq. miles (Lewis, 1909).

The following is a list of specimens collected from the islands during this tour :—

A. FISHES

1. Marine

a. **Plotosus anguillaris** (Bloch). Off Leyden. A shoal of young about 1½ inches in length were collected from near the shore. These were observed from time to time to swarm together and to swim out.

b. **Tylosurus strongylurus** (Van Hasselt). Eluvativu. Dorsals I, 13. Anals I, 15. Pectorals I, 10. Ventrals I, 5. Total length 337 mm. One specimen.

c. **Tylosurus giganteus** (Schlegel). Leyden. Dorsals 21. Anals. 18. Pectorals 14. Total length of largest specimen is 400 mm., of which the head length is 120 mm. Two specimens.

d. **Hemirhamphus xanthopterus** Cuvier and Valenciennes. Leyden. Dorsals 16. Anals 15. Pectorals 13. Total length is 300 mm. One specimen.

e. **Hemirhamphus far** (Forskal). Leyden. Dorsals 13. Anals 12. Pectorals 12. Total length is 398 mm. One specimen.

f. **Liza dussumieri** (Valenciennes). Eluvativu. Dorsals IV, 8. Anals III, 9. Pectorals 16. One specimen.

g. **Epinephelus tauvina** (Forskal). Eluvativu. Dorsals XI, 15. Anals III, 8. 5 vertical bands on body. Total length is 160 mm. One specimen.

h. **Sillago sihama** (Forskal). Eluvativu. Dorsals XI, 22. Anals 26. Ventrals I, 5. Total length is 125 mm. One specimen.

i. **Siganus javus** (Linné). Karaitivu. Dorsals XIII, 10. Anals VII, 9. Ventrals II, 3. Total length is 105 mm. One specimen.

j. **Thysanophrys indicus** (Linné). Leyden. Collected at night close to the shore. Dorsals I, VII, 13. Anals 13. Total length of largest specimen is 144 mm. Two specimens.

k. **Torquigener oblongus** (Bloch). Leyden. Collected at night close to the shore. Dorsals 12. Anals 10. Total length of largest specimen is 120 mm.

l. **Chelonodon patoca** (Hamilton-Buchanan). Leyden. Dorsals 10. Anals 9. Immature specimens nearly 50 mm. in total length.

II. Brackish Water

a. **Lepidocephalichthys thermalis** (Cuvier and Valenciennes). Leyden. Three V-shaped bands on caudal fin. Total length of largest specimen is 61 mm. Three specimens.

b. **Macrones gulio** (Hamilton-Buchanan). Karaitivu and Punkudutivu. Total length of largest specimen is 113 mm. Four specimens.

c. **Hemirhamphus gaimardi** Cuvier and Valenciennes. Immature specimens. Karaitivu and Leyden. Numerous specimens 38–76 mm. in total length.

d. **Mugil speigleri** Bleeker. Karaitivu and Analativu. Total length of largest specimen is 98 mm. The specimen from Analativu was from a pool of freshwater.

e. **Liza oligolepis** (Bleeker). Karaitivu. Height of body $3\frac{2}{3}$ inches in total length. Largest specimen is 51 mm.

f. **Ambassis commersoni** Cuvier. Karaitivu. Dorsals VII, I, 10. Anals III, 10. Total length of largest specimen is 40 mm. Three specimens.

g. **Therapon jarbua** (Forskål). Karaitivu. Dorsals XI, 10. Anals 8. One specimen.

h. **Gerres oyena** (Forskål). Karaitivu and Leyden. Dorsals IX, 10. Anals III, 7. The 2nd dorsal spine 2 in. head length.

i. **Scatophagus argus** (Linné). Karaitivu. Total length of largest specimen 59 mm. Four specimens.

j. **Etroplus maculatus** (Bloch). Karaitivu and Leyden. Dorsals XVII-XVIII, 10-11. Anals XII-XIII, 8-9. Pectorals 14. Ventrals I, 5. Caudals 16. Depth of body 2⅘ in. total length. Four specimens.

k. **Glossogobius giuris** (Hamilton-Buchanan). Karaitivu. Total length 53 mm. One specimen.

B. AMPHIBIANS

1. **Rana tigrina crassa** Jerdon. Karaitivu and Leyden.

2. **Rana cyanophlyctis** Schneider. Karaitivu, Leyden, and Punkudutivu. Collected from both fresh and brackish water pools and ditches. It was observed that the body colour of those from the brackish-water pools and ditches was much paler and more yellowish than in those from fresh water. The dorsal blotches so conspicuous among those from the freshwater pools and ditches were hardly decipherable.

3. **Rana breviceps** Schneider. Leyden, Punkudutivu, Nainativu, and Delft.

4. **Rhacophorus leucomystax maculatus** (Gravenhorst). Punkudutivu, Analativu, Eluvativu, and Nainativu.

5. **Microhyla ornata** (Dum. & Bibr.). Leyden.

6. **Microhyla rubra** (Jerdon). Leyden, Analativu, and Nainativu.

7. **Bufo melanostictus** Schneider. Karaitivu, Leyden, Punkudutivu, Analativu, and Nainativu.

8. **Bufo fergusonii** Boulenger. Analativu.

C. REPTILES

1. **Melanochelys trijuga** (Schweigger). Nainativu.

2. **Lissemys punctata ceylonensis** (Gray). Leyden and Punkudutivu.

3. **Hemidactylus frenatus** Schlegel. Numerous on the palmyrah trees in all the islands, descending to the ground at night.

4. **Hemidactylus triedrus triedrus** Lesson. Eluvativu. Four specimens, two males and two females. Femoral pores 7/7 and separated by a single scale. The femoral pore counts from a number of specimens from the mainland of Ceylon are as follows: (*a*) 7/7 and separated by a single scale, Tunnakai (N.P.); (*b*) 12-13/12-13 and 17/15 and separated by three scales, Trincomallee (N.P.); (*c*) 17/16 and separated by three scales, Batticaloa (E.P.); (*d*) 17-18/11-17 and separated by three scales, Wellawaya (S.P.), and (*e*) 18/19 and separated by three scales, Gammaduwa (C.P.). It is evident that

the range of distribution of the *forma typica* appears to extend as far south as the northern province of Ceylon. It may even be that the Eluvativu and Tunnakai specimens belong to a new race but more information is necessary to elucidate this.

5. **Hemidactylus brooki parvimaculatus** Deraniyagala. Analativu.

6. **Hemidactylus leschenaulti** Dum. and Bibr. Nainativu and Delft.

7. **Calotes versicolor** Daudin. Rather scarce. Practically in all the islands.

8. **Sitana ponticeriana** Cuvier. Leyden. Young specimens, fairly numerous on the sand dunes on the western shore.

9. **Mabuya carinata** (Schneider). Karaitivu, Mandaitivu, and Delft.

10. **Riopa punctata** Gmelin. Nainativu and Delft. A specimen was collected along with three specimens of *Echis carinatus* under a fairly large coral stone in the open plains of Delft.

11. **Varanus bengalensis** (Daudin). Leyden.

12. **Ptyas mucosus** (Linnè). Karaitivu and Delft.

13. **Oligodon arnensis albiventer** (Günther). Analativu. Supralabials 7, 3rd, and 4th touching eye. Praeoculars 1. No loreal. Costals 17, 17, 17. Ventrals 172. Subcaudals 47. Anals 2. 18 black bands from neck to vent and 6 on tail with two incomplete bands.

14. **Dendrelaphis** sp. Analativu. Specimen seen only.

15. **Lycodon aulicus** (Linnè). Eluvativu. Collected at night from the sides of a well. Supralabials 9, 3rd, 4th, and 5th touching eye. Praeoculars 1. Loreals 1. Costals 17, 17, 17. Ventrals 189. Subcaudals divided and number 60. Anals 1.

16. **Dryocalamus nympha** (Daudin). Nainativu. Collected at night at the foot of a coco-nut tree and supposed to be numerous according to the inhabitants. Supralabials 7, 3rd, and 4th touching eye. Praeoculars 1. Loreals 1. Internasals 2. Costals 13, 13, 13. Ventrals 209. Subcaudals 77. Anals 2. 33 white bands on body between neck and vent and 22 on tail.

17. **Naja naja naja** Linnè. Analativu.

18. **Echis carinatus** Schneider. Mandaitivu, Punkudutivu, Nainativu and Delft.

D. BIRDS

1. **Butorides striatus javanicus** (Horsfield). Eluvativu.

2. **Ardeola grayii** (Sykes). Karaitivu, Leyden, Punkudutivu, Eluvativu, Analativu and Nainativu.

3. **Ardeola ibis coromanda** (Boddaert). Karaitivu, Punkudutivu, Analativu, and Nainativu.

4. **Nycticorax nycticorax nycticorax** (Linné). Karaitivu.

5. **Haliastur indus indus** (Boddaert). Karaitivu, Leyden, Mandaitivu, Eluvativu, Analativu, Nainativu and Delft.

6. **Accipiter badius badius** (Gmelin). Delft.

7. **Circus macrourus** (S. G. Gmelin). Delft.

8. **Circus aeruginosus aeruginosus** (Linné). Delft.

9. **Falco tinnunculus tinnunculus** Linnaeus. Leyden, Mandaitivu, Eluvativu, Analativu, and Nainativu.

10. **Francolinus pondicerianus ceylonensis** Whistler. Karaitivu, and Delft.

11. **Lobipluvia malabarica** (Boddaert). Delft.

12. **Pluvialis dominica fulva** (Gmelin). Leyden, Eluvativu, Analativu, and Delft.

13. **Charadrius dubius curonicus** Gmelin. Leyden, Mandaitivu, Punkudutivu, Eluvativu, Nainativu, and Delft.

14. **Charadrius alexandrinus seebohmi** Hartert & Jackson. Punkudutivu.

15. **Tringa glareola** Linnaeus. Delft.

16. **Actitis hypoleucos** (Linné). Eluvativu and Nainativu.

17. **Erolia temminckii** (Leisler). Mandaitivu.

18. **Erolia testacea** (Pallas). Analativu.

19. **Larus ichthyaetus** Pallas. Delft.

20. **Larus brunneicephalus** Jerdon. Leyden, Mandaitivu, and Punkudutivu.

21. **Chlidonias leucoptera** (Temminck). Leyden.

22. **Gelochelidon nilotica nilotica** (Gmelin). Leyden and Punkudutivu.

23. **Hydroprogne caspia caspia** (Pallas). Leyden.

24. **Sterna albifrons sinensis** Gmelin. Delft.

25. **Streptopelia chinensis ceylonensis** (Reichenbach). In all the islands.

26. **Psittacula krameri manillensis** (Bechstein). In all the islands.

27. **Clamator jacobinus jacobinus** (Boddaert). Delft.

28. **Clamator coromandus** (Linné). Leyden.

29. **Eudynamis scolopacea scolopacea** (Linné). Leyden and Analativu. A single female bird (juvenile) was collected from Analativu and its upper plumage was distinctly blacker with the feathers on the lores, cheeks and nape tipped rufous. Faint patches of rufous also seen on the wings and the tail feathers.

30. **Centropus sinensis parroti** Stresemann. Karaitivu and Leyden.

31. **Caprimulgus asiaticus eidos** Peters. Leyden.

32. **Collocalia brevirostris unicolor** (Jerdon). Karaitivu, Leyden, Eluvativu, Analativu, Nainativu, and Delft.

33. **Ceryle rudis leucomelanura** Reichenbach. Karaitivu, Leyden, and Analativu.

34. **Halcyon smyrnensis fusca** (Boddaert). Leyden, Eluvativu, Analativu, Nainativu, and Delft.

35. **Merops phillippinus philippinus** Linnaeus. In all the islands.

36. **Merops orientalis ceylonicus** Whistler. Karaitivu, Eluvativu, Analativu, Nainativu, and Delft.

37. **Coracias benghalensis indica** Linnaeus. In all the islands.

38. **Upupa epops ceylonensis** Reichenbach. Karaitivu.

39. **Megalaima zeylanica zeylanica** (Gmelin). Karaitivu.

40. **Dinopium benghalense jaffnense** (Whistler). Karaitivu, Leyden, Eluvativu, and Analativu.

41. **Eremopterix grisea ceylonensis** Whistler. Nainativu and Delft.

42. **Anthus novaeseelandiae richardi** Vieillot. Mandaitivu and Delft.

43. **Anthus novaeseelandiae malayensis** Eyton. Karaitivu and Leyden.

44. **Pericrocotus peregrinus ceylonensis** Whistler and Kinnear. Punkudutivu and Analativu.

45. **Coracina novaehollandiae layardi** (Blyth). Punkudutivu.

46. **Artamus fuscus** Vieillot. Eluvativu, Analativu, Nainativu, and Delft.

47. **Pycnonotus cafer cafer** (Linné). Karaitivu, Leyden, and Delft.

48. **Pycnonotus luteolus insulae** Whistler and Kinnear. Punkudutivu.

49. **Saxicoloides fulicata fulicata** (Linné). Leyden and Mandaitivu.

50. **Copsychus saularis ceylonensis** Sclater. Karaitivu and Leyden.

51. **Orthotomus sutorius sutorius** (Pennant). Nainativu and Delft.

52. **Prinia inornata insularis** (Legge). Delft.

53. **Rhipidura aureola compressirostris** (Blyth). Nainativu, and Analativu.

54. **Nectarinia asiatica asiatica** (Latham). Punkudutivu, Eluvativu, and Delft.

55. **Nectarinia zeylonica zeylonica** (Linné). Karaitivu, Analativu, and Nainativu.

56. **Ploceus philippinus philippinus** (Linné). Delft.

57. **Lonchura malabarica** (Linné). Analativu and Delft.

58. **Passer domesticus soror** Ripley. Analativu.

59. **Sturnus pagodarum pagodarum** (Gmelin). Delft.

60 **Acridotheres tristis melanosternus** (Legge). Leyden, Mandaitivu, Eluvativu, Analativu, Nainativu, and Delft.

61. **Dicrurus macrocercus minor** Blyth. In all the islands.

62. **Corvus splendens protegatus** Madarasz. Leyden, Mandaitivu, Eluvativu, Analativu, Nainativu, and Delft.

63. **Corvus macrorhynchos culminatus** Sykes. Mandaitivu, Analativu, and Nainativu.

E. MAMMALS

1. **Tatera indica ceylonica** Wroughton. Leyden.

2. **Rattus rattus kandianus** Kellart. Analativu.

3. **Funambulus palmarum brodiei** (Blyth). Leyden and Delft.

4. **Herpestes flavidens maccarthiae** Gray. Delft.

DISCUSSION

No detailed information regarding the physical and climatic features of these islands is available and it is proposed, therefore, in view of their situation within a radius of twenty miles of Jaffna to consider the conditions occurring in the Jaffna Peninsula as the conditions likely to prevail over these islands.

Geologically the Jaffna Peninsula as well as the islands consist of a huge limestone block and the islands represent the submerged portion of the Peninsula (Cook, 1951, p. 330). It is of Miocene age belonging to the Kudremale-Jaffna series (Coates, 1935, p. 104) and of the calcareous facies (Adams, 1929, p. 443). The Peninsula as well as the islands are flat and low-lying with outcrops of limestone, especially in the northern parts of the Peninsula and in many of the islands especially Delft. The limestone in the Peninsula is highly fossiliferous, the fossils being mainly of foraminifera and mollusca. A. M. Davies who made a study of these fossils is of opinion that the Puttalam-Jaffna limestone series is of Pontian or Sahelian age, and that these rocks are identical with similar rocks at Quilon in Travancore (Coates, 1935, p. 105). The thickness of the limestone in the Peninsula is unknown, but it is presumed to be some hundreds of feet deep. The limestone bed of the Peninsula is fairly level as it extends under the sea. Consequently, the sea water enters the underground circulation. The thick bed of porous limestone allows the water to percolate rapidly and the rain water being slightly acidic riddles the limestone with tiny holes. As a result the surface is left dry and all the water sinks below to circulate in these holes. Caverns and underground rivers are common and the wells in the Peninsula some distance away from the sea have salty water in them, and in other parts freshwater springs occur on the shore. Practically the water in most of the wells in the island is also salty. At Leyden, Analativu, and Nainativu there were pools of fresh water at the time of my visit. The inhabitants of the island of Eluvativu were seen to drain off for drinking purposes the water collected in shallow pits near the shore. The conditions are much more severe in the islands than in the Peninsula, especially Eluvativu and Delft where there is so little fresh water that cultivation is extremely difficult and the inhabitants have always to drink coco-nut water and toddy (Cook, 1951, p. 137). Grey loams occur in the islands and, as in the Peninsula, these support paddy cultivation while the remaining parts are sandy, allowing the cultivation of cereals in favourable patches and the growth of the palmyrah palm. Cacti and thorny scrub predominate in the stretches of open country.

These islands in common with the northern and north-western tracts of the Peninsula come under the 'arid zone' with an annual rainfall of between 25″—50″. 60% of the total rainfall occurs in the months of the north-east monsoon. The climate is marked by a 'single maximum rain "peak" in winter due to the strong NE. Monsoon dominancy and with a marked "summer" dry season.' (Thambiahpillay, 1954, pp. 37 and 49). The average monthly rainfall as computed for 29 years from 1911–1940 (Thambiahpillay, 1954, XII, No. 4, p. 269) is as follows :—

Station	J	F	M	A	M	J	J	A	S	O	N	D
Jaffna	4.4″	1.5″	1.5″	2.2″	2.0″	0.4″	0 5″	1.1″	2.5″	9.2″	10.5″	10.4″

The average number of 'rainy days' for Jaffna as computed for 29 years, i.e. 1911–1940 (Thambiahpillay, 1954, XII, No. 4, p. 270) are as follows :—

Station	J	F	M	A	M	J	J	A	S	O	N	D
Jaffna	8	3	3	5	3	1	1	3	4	12	18	14

The number of days of drought for Jaffna are 223 for 1931 and 190 for 1932 (De Silva, S. F., 1936, p. 55).

The average rainfall for the western portion of the Peninsula and the islands is less than 10 inches during the months of the south-west monsoon. Rains begin usually in September. October to December are the wet months and by January sunny weather begins.

The average temperature over Jaffna and the islands is about 82°F. Jaffna shows a seasonal variation in temperature of 8°F. and shows also the highest rise in temperature in the months of March and April. This rise in temperature is presumed to be caused by the warm air over the Deccan exerting an influence. The smallest range of temperature occurs in the months of June and July, when the humidity of the air is 76–78%, and this accounts for this small range of variation. The highest range of variation occurs in the month of February, during which period the humidity of the air is the lowest being 66%. The Precipitation Index for Jaffna is 69.1 and the Temperature Efficiency is 147.

Sifting the above environmental features of the Peninsula and the islands the following factors may be considered to influence the animal populations inhabiting them :—

a. the porous nature of the limestone composing the Peninsula and the islands, which allows the rain water to percolate rapidly leaving the surface dry ;
b. the entry of sea water into the underground circulation, resulting in the water in most of the wells becoming salty ;
c. the average rainfall being between 25-50 inches and 60% of the rainfall occurring in the months of October to December ;
d. the average temperature being 82°F., the highest range being shown in the months of June and July ; and
e. the number of days of drought being over 190.

It is evident, therefore, that the primary factor that controls the animal populations in the islands is the availability of fresh water and, consequently, the type of land animals inhabiting them must be able to withstand the long dry spell. It is very likely that during the rainy season there is an annual exodus of land animals from the Peninsula to the islands that are now connected with it, and in these they spread widely. But with the commencement of the dry spell those animals that took their abode near freshwater wells alone could survive, whilst the others would perish. As a result animals are everywhere scarce during the dry months in these islands. The common garden lizard, *Calotes versicolor*, so profusely met with in the mainland of Ceylon, is seldom seen, and I did not see more than six specimens during my sojourn in all the islands off Jaffna. All the temporary pools and ditches would be dry by April, and the specimens of *Rana tigrina crassa* and *Rana cyanophlyctis* living in them would perish. Therefore, the few land animals who are fortunate enough to establish themselves in the vicinity of freshwater wells would alone survive. In the islands of Analativu and Nainativu there is a small community of land animals living in close proximity to the wells and taps, either in holes and crevices or under heavy stones. The water used by the inhabitants for washing and bathing purposes keeps the ground near the wells moist, and at nightfall all these animals creep out of their shelters to hug the moist earth. At Analativu I saw specimens of *Rhacophorus leucomystax*, *Microhyla rubra*, and *Bufo melanostictus* around bathing wells, and at Nainativu specimens of *Rana breviceps*, *Rhacophorus leucomystax maculatus*, *Microhyla rubra*, *Bufo melanostictus*, and *Echis carinatus* around the water taps.

The absence of *Rana tigrina crassa* and *Rana cyanophlyctis* in those islands not connected with the Jaffna Peninsula, such as Eluvativu, Analativu, Nainativu, and Delft, indicates that these forms are unable to survive in them in the absence of permanent pools or wells of fresh water.

Both spend a good deal of their time in water and, even though a few of them could have got across to these islands through the agencies of launch and canoe, the absence of fresh water would have been detrimental to their survival, and the pioneers would have perished. At the same time *Rana cyanophlyctis* was collected from pools of brackish water, although it is considered to be essentially a freshwater form. In this respect it may be regarded to display some degree of 'ecological plasticity', which would have favoured their survival in the salty water of the wells in these islands. Either the water in the wells is too salty, thus precluding any amphibian life, or that the launch and canoe are not efficient means of dispersal may perhaps be the reason why *Rana tigrina crassa* and *Rana cyanophlyctis* are not found to occur in those islands not connected with the Peninsula.

In any discussion of an island fauna the effects of geographical isolation should find an important place. Till recently all these islands remained separate, and during this period geographic isolation was nearly complete except for any dispersal through the agency of the canoe. 'Isolation', according to Deraniyagala (1947, p. 76) 'first exerted a major influence upon Ceylon when the islands separated off the mainland of Asia during Miocene times. Extensive tracts especially to the north of Ceylon went under the sea to emerge subsequently to connect with the mainland.' The islands off Jaffna Peninsula therefore represent the submerged portion of the Peninsula which have been elevated subsequently. The island of Karaitivu lies at a distance of nearly two miles from the Peninsula and separated from Leyden by nearly half a mile. Mandaitivu is situated in close proximity to Leyden and Punkudutivu nearly 2½ miles from Leyden. The island of Leyden lies nearly 2 miles from the Peninsula. All these islands mentioned above have been connected with one another and with the Peninsula during recent times by ferry and causeways. The islands of Eluvativu, Nainativu, and Delft remain separate even to this day. There is no doubt, therefore, that in all these islands the chief ecological barrier which restricted the 'flow of individuals from one population to another' was the stretch of water separating them. But with the construction of causeways and the inauguration of a ferry service these stretches of water have ceased to be an ecological barrier preventing animal dispersal. It is true that stretches of water do not serve as ecological barriers to the dispersal of most insects and birds, especially so when the distance concerned is so little. I have seen the butterfly *Polydorus hector* Linné and the Indian Edible Swift flying across over the sea from Leyden in the direction of Analativu, and a carpenter bee following our launch all the way from Nainativu to Kayts. But there is no doubt that water is an effective barrier in the case of land animals, and the only means of animal dispersal to these four islands, namely Eluvativu, Analativu, Nainativu, and Delft, must be through canoe and launch which ply between them.

The animals collected from the islands do not appear to display much variation in spite of such intensive geographic isolation, and most of them are identical with the Peninsular forms. The only specimens of interest are specimens of *Rana breviceps*, which appear to be diminutive with its dorsal body colour bluish green, and *Echis carinatus*, which displays a higher range of circumorbital scales. The specimens collected from the islands are all of south Indian stock. It is evident, therefore, that a more comprehensive collection is necessary to elucidate how far geographical isolation has been accompanied by the development of biological isolating mechanisms.

Although detailed evidence is lacking it is necessary to make a passing reference as to how land animals in these islands tide over the long dry spell. I have seen a specimen of *Ptyas mucosus* at Delft hiding in a hollow of a tree nearly seven feet from the ground. I have collected three specimens of *Echis carinatus* and a specimen of *Riopa punctata* from under a large coral stone in the open plains of Delft. Four immature specimens of *Rana breviceps* were collected from under a coral stone near the drying lagoon, hiding themselves in a crab burrow. I have seen *Rhacophorus leucomystax maculatus* in enclosures on the ground near pipe connections. Close to these taps, in holes, crevices and under stones, I have collected specimens of *Bufo melanostictus* and *Echis carinatus*. I have also seen at Delft the mongoose hiding in caverns in large coralline rocks close to the shore. This should also be another aspect that should receive a closer study.

In conclusion I wish to compare this collection of zoological specimens with another collection from the island of Rameswaram made by Edgar Thurston (1895). I wish to comment upon the birds only. Of the 28 birds listed by him the following birds also occur in the islands off Jaffna: Kestrel, Shikra, Common Bee-eater, Goldenbacked Woodpecker, Pied Crested Cuckoo, Common Coucal, Indian Hoopoe, Black Drongo, Madras Redvented Bulbul, Magpie Robin, Jungle Crow, House Crow, Brahminy Myna, Spotted Dove, and Brownheaded Gull.

REFERENCES

Adams, F. D. (1929) : The Geology of Ceylon. *Res. Council of Canada.*
Cain, A. J. (1954) : Animal Species and their Evolution : 130–168.
Carter, G. S. (1952) : Animal Evolution : 223-237.
Coates, J. S. (1935) : The Geology of Ceylon. *Ceylon J. Sci.* (B), **19** : 101–107.
Cook, E. K. (1951) : A Geography of Ceylon.
Day, F. (1878) : The Fishes of India.
Deraniyagala, P. E. P. (1946) : Some Phases of the Evolution of Ceylon. *Proc. Ass. of Sci. Sec.* D. 69-86.
— — — (1951) : Some New Races of the Snakes *Eryx*, *Callophis* and *Echis*. *Spol. Zeylan.* **26** (2). 148.
— — — (1953) : A Coloured Atlas of Some Vertebrates from Ceylon. Vol. II—Tertrapod Reptilia.
— — — (1955) : A Coloured Atlas of Some Vertebrates from Ceylon. Vol. III—Serpentoidea.
De Silva, S. F. (1936) : The New Geography of Ceylon.
Ellerman, J. R. and Morrison-Scott, T. C. S. (1951) : Checklist of Palaearctic and Indian Mammals : 297–298 and 637.
Fernando, L. J. D. (1954) : Progress of the Geological Survey of Ceylon. *Bull. C.G.S.* 1–10.
Huxley, J. (1940) : The New Systematics.
Lewis J. F. (1909) : Notes on Delft. *J.R.A.S.* (Ceylon) : 341–360.
Mayr, E. (1942) : Systematics and the origin of Species : 216–274.
Munro, I. A. S. (1955) : The Marine and Freshwater Fishes of Ceylon.
Phillips, W. W. A. (1953) : A (1952) Revised Checklist of the Birds of Ceylon.
Smith, M. A. (1943) : Fauna of British India (Reptilia), Vol. III.
Thambiahpillay, G. (1954) : The Rainfall Rhythm in Ceylon. *Univ. Ceylon Rev.* **12** (4) : 224.
— — (1954) : Ceylon and the world climatic mosaic. *Univ. Ceylon Rev.* **12**, (1) : 24.
Thurston, E. (1895) : Rameswaram Island and the Fauna of the Gulf of Mannar. *Madras Govt. Mus. Bull.*, 77–89.
Wait, W. E. (1931) : Manual of the Birds of Ceylon.
Wall, F. (1921) : Notes on Some Ceylon Snakes. *Spol Zeylan.* **11** : 399.
— (1921) : The Snakes of Ceylon.

FURTHER OBSERVATIONS ON THE FAMILY LIFE OF THE FIVE-STRIPED SQUIRREL, *FUNAMBULUS PENNANTI* WR.

BY

(MRS) ARUNA BANERJI

Since the publication of my first article in the December 1955 issue of the *Journal* [Vol. 53 (2): 261] I have continued my notes and am now in a position to give a further account of the family life of the most interesting of pets, the squirrel.

On 26 July 1955 my pet squirrel had had her fifth litter of three. Since early morning of August 29, she had a retinue of suitors who gave her hot chase. She was finding out the queerest of hiding places because, I think, she was not quite ready for mating and had been accidentally discovered. The young ones were just one month and three days old. She had had a hard time and looked a little ruffled by the evening, and once even jumped on to the courtyard from the asbestos roofing when in the clutch of a male during mating, very unusual behaviour.

On September 1, I found that her young ones had not left the nest as yet and the nest-building instinct of the mother had been awakened. She went into our dressing-room and investigated a wall almirah of books, behind which she found a place that appealed to her. The next moment she was frantically pulling at a silk blouse that was on the cloth-rack next to it. I retrieved that from her grasp and gave her two pieces of cloth which she arranged into a nest behind the books. In the evening she went back to her young ones in the wooden box in her original almirah. Every morning she went about building her new nest, but the moment I took down the books which she was happily chewing and gave her a cardboard box instead, she took offence and left the site.

On September 11, my mother complained of a tear in the mattress from which cotton was missing. Next morning she called me to show the latest nest. A window of the room had been kept closed all through the winter months. The room had become stuffy so mother had opened the window. Against it and the *chik* that was always hanging stood her nest of cotton taken from the mattress. The moment the squirrel saw that her nest had been discovered she started taking the materials out and deposited them in the wooden box still containing the young. They are now one and a half months old.

That same evening I went over to our cottage where, chatting over tea, I heard a young squirrel give a call at a distance. It was rather late and the calls persisted at intervals so that I was definite the mother was nowhere about or else she would most certainly have come to that call.

I went out of the gate and into the lane and, after much searching, found the baby squirrel peeping out of a crevice in the wall next to a drain. I put my hand in to extricate her and she licked my finger but was afraid to come out. At last while trying to catch hold of her she ran out and went along the drain. I gave chase and caught her, completely soaked in drain-water. After giving her a bath I rubbed her dry with a towel and let her rest to quiet down her heart-beat. That very night she sucked milk and came to me the moment I called. Probably hunger and loneliness throughout the day was the cause of such quick tameness, the first so far in my experience.

Her I shall call Squirrel Junior to distinguish her from my two-year old pet, Squirrel Senior.

On September 14, I found neither the mother nor the young ones in the wooden box when I went to clean the almirah and change the papers. Near about 7.45 p.m. I heard one of the young squirrels calling out. The sound came from the first storey but the next moment there was a sound of something falling, and there was the young one on the ground. He went up the stairs again calling at intervals, and I followed him. As I watched the young one by torch-light I saw the mother come to him and guide him up the girder and on to the roof. Every time the young one fell in the attempt and whimpered, the mother came down immediately and began coaxing him up again. Finally she succeeded. Then she wanted him to go up into a room through a hole which was on a higher level. When he finally did succeed goaded all along by his mother, the watch read 8.45 p.m., exactly one full hour's perseverance.

Then I understood that, in that room above, the mother had made a nest for her coming litter after her nest behind the window had been discovered by us. She had transferred all the material from the old site to the new.

One night I stayed back at Dehra Dun. Next morning she must have come as usual for her snack and not found me. Near about 3.30 p.m. when I went out on to the courtyard and looked up I saw the mother playing with her two young ones on the roof-top. The next moment she saw me, though I had not called out to her, she recognized me and came down the girder and the stairs, her usual route. I was deeply impressed by her intelligence.

Squirrel Senior comes morning and evening for a snack and goes straight to the dining room. If she does not find me there she comes to the drawing room where I usually study. When I call her back to the dining room she makes a go for the dining table and waits for me to open the Frigidaire in which I keep her provisions. Once it so happened that my cousin was reading in the drawing room and I was in the kitchen. About ten minutes later she came and called me. The squirrel had been in the drawing room she said and, failing to attract her attention for the past fifteen minutes, had finally come forward and nipped her to make her realize the fact that she was waiting to be fed.

One day I saw a surprising drama at the cottage. From the stairs I was watching a wall with crevices when I noticed two adult males at play. All of a sudden one went along the vertical surface of the wall peeping into the crevices. Three were empty, and at the fourth he stopped and became tense. I was certain there was a nest there and a squirrel was sitting inside. The next moment there was something rushing out and the possessor of the nest chased the intruder hotly. She then came back to her nest and she looked so odd with just a stump of a tail like a rabbit, and I also noticed she was quite near confinement. The intruder who had not learned a lesson the first time came inquisitively again to impress himself upon her, but she was in no mood for his attentions and gave him a second chase when he was bold enough to step inside her nest. He then realized he was actually unwanted and did not come back a third time.

My Squirrel Junior has become a great pet. She has her box on a table in the drawing room. When I go to bed I lock the door for fear of rats, and the squirrel sleeps quietly through the night in darkness.

Early morning she has a tablespoonful of warm sweetened milk. If I enter her room noiselessly she does not stir, but the moment she hears voices she steps out of her box, stretches herself, and puts out her long pink tongue as she yawns shamelessly. She is active as long as there is somebody in the room to appreciate her activities. As soon as she finds everything quiet about her she jumps on to the table and into her box and enjoys a quick nap.

In the evening she is literally sleepy and curls herself cosily in the lap, and sucking and playing with a finger falls asleep very quickly. On October 5, 1955, Squirrel Junior has been with me 24 days. Nuts and grapes are her favourite.

On October 11, 1955, I could not recognize my Squirrel Senior when she came down for her snack in the afternoon. Yesterday she was plump and round and today she is as slim as ever. I could guess she had delivered her litter in the room upstairs either last night or early this morning. The gestation period in this sixth instance was exactly one month and 12 days.

I came back from a holiday on January 9, 1956, and found my mother feeding a whole retinue of squirrels on the verandah of our first storey. They came for food but not to the feeder. I continued giving them food but on strict condition that they came to take it from my hand. Squirrels Senior and Junior came directly, and the rest, about 7 or 8 in number, gradually lost their fear. The moment they see me making for the verandah they come down from the roof where they laze in the morning sun. If for some reason I cannot make it or am late they come down on to the courtyard in a band and thus attract my notice.

Among these regular attendants are Senior's youngsters from the last litter, two in number. One of them is an albino and very small and scraggy for its age. I think there must be some vitamin deficiency in the mother's diet because she too, I find, has developed a marked white spot on her forehead, and the upper half of her body seems to be getting lighter in colour.

There was a swarming of suitors since 11 in the morning of January 14, 1956, and Squirrel Senior was hiding while frantic searches were on. I watched expectantly but I had to go to the railway station to receive some guests and consequently missed the drama. When I came from the cottage the next morning my servant mentioned the fact that a squirrel had dropped on the courtyard from the first storey and stayed there stunned for a time before getting away. Maybe the mating was in progress and she had fallen while trying to extricate herself from the iron grip of her suitor.

On February 25, 1956, as I was talking to a friend in the drawing room my pet squirrel came in and sat on the top of the sofa. I gave her pistachio nut which she devoured greedily. Then I saw blood on her left flank and on the back left foot. For the time being I took her to be Squirrel Senior, and seeing her bleeding I decided that she had been delivered that morning and now she had come to be fed.

Then, as I went to the dining room, imagine my surprise when I saw Senior on the casing. Seeing me she came down into her almirah and it was then that I noticed that she was as slim as ever and I realized that she had been delivered either the night before or early that morning. Hence as was her custom she had not been out that morning but was resting after the ordeal and keeping watch. The gestation period in this seventh litter comes to one month and 11 days.

Recognizing Senior, it dawned on me that the squirrel in the drawing room was my pet Junior who was now 6 months old and mature. She had been surprised and waylaid and in the onslaught that had followed her coming of age declaration, blood had been drawn. Pursued by her suitors relentlessly she had come to us for shelter.

There was pandemonium on the stairs, and in the courtyard hell let loose. After feeding her and quenching her thirst I quietly closed the door of the drawing room. The moment she had got back her breath she showed keenness to go out. She would advertise herself by springing on to the wire-meshed door that opens on to the courtyard. There would be frantic displays by the suitors who gave call after call coming on to the wire-meshed door from the outside.

Carefully I slipped in an eager male into the drawing room and quickly closed the door. The moment he went towards her on the couch constantly wooing her with his soft calls she came forward coyly to him. Thus they mated quietly for ten minutes until suddenly she threw him off with a struggle and a bite. I was surprised to note that he was very keen for a second mating but she was no longer willing. There were too many suitors outside who incessantly called to her. Then it struck me that she was all for variety because, no sooner had I released her, she ran up the stairs hotly pursued by her suitors, and I caught up with her quietly mating behind the box-room door immediately after. Her late suitor was still imprisoned in the drawing room. It was then that I realized why there were so many competitors on the field and why they did not leave soon after the first mating but stayed on till the close of the day.

This love life went on till 6.30 p.m. when with fading light the suitors left one by one. With my pet Squirrel Senior conditions had been somewhat different. She was more used to the house. So naturally, when pursued, she would hide within the rooms where disturbance was likely to be less. Consequently there were fewer matings but each lasted longer, but now I am certain that in her case too there must have been more than just one suitor who had successfully wooed her. Monogamy is far from the rule in the squirrel kingdom; on the contrary, I think that there is a far greater likelihood of the majority, if not all, of the suitors having a fair chance of successfully wooing a willing female in a given area.

As a rule the love life of a squirrel lasts but a day. For the first time I saw it continued, though for an instant, the next day. On the afternoon of February 26, Junior mated again. The mating was a lone case with no competitors on the field, and a half-hearted affair signifying nothing. They had come across each other accidentally, not deliberately as yesterday, and they separated immediately.

On March 3, 1956, I saw Squirrel Junior for the first time collect cotton wool for the nest she had to build for her future litter, an instinct awakened exactly a week after the mating took place. I had placed some cotton wool in a hollow under the tank. She had not needed it then but had carefully noted the place. Now when the need arose she came down with that definite intention and went straight for it. She rolled a little of it at a time into manageable balls and made a number of trips up to a second storey room where the cots are kept.

On April 7, 1956, Squirrel Senior mated for the eighth time being just two years and six months old. The young ones from her last litter are just one month and 13 days old. For the last two days I have been watching her getting male attention, but she never lets them come any nearer. That day I had not noticed anything at first until I went up to feed them and found none, and understood that for the day food was of minor importance. A full band of suitors, half-tailed, three quarter, and whole, were hot on her trail while she was constantly giving them the slip. Once in the process of mating I saw a second male cover the first male and bite him to make him lose his hold. In the meantime a third male came and covered the second male. Yet the original male was oblivious of the pandemonium behind him though the female was struggling to free herself. Another time in the process of mating on the roof of the next compound they managed to attract the attention of a kite which came low to catch them in its talons, but they rolled away just in time and missed being food for it. When all was quiet with the coming on of dusk, Squirrel Senior came down to her almirah where I had kept warm tea for her, knowing that she would be very thirsty. She lapped it up, stretched and cleaned herself, and then went into the box where the two young ones were waiting for their feed. She had come to them after 12 hours, to be exact.

Both Squirrels Senior and Junior enter the kitchen for a brief respite because it is a hiding place for them as well as a provision store. The males are not primarily interested in food, but if a monkey-nut comes in the way the finder does justice to it while the rest follow the chase which is not for a moment given up until after dark.

There is a funny incident connected with this wooing. On March 18, 1956, I had taken out a female from Senior's seventh litter to bring up when she was three weeks old. By April 7, she had become a great pet, and that afternoon as I lay down beside her wooden box she was frisking all over me. One suitor had come into the room in search of Squirrel Senior. He saw the young one, and with very sweet calls he came wooing her while I lay stiff and watched. He came on to my body, and the moment he was face to face with the youngster she gave him such a clucking with the teeth that he drew back, but came forward again and again, calling all the time.

She would have none of him and drove him away with her gnashing teeth and rushing forward, so that he finally left her in peace.

When the male suddenly discovers the hide-out of the female he makes such a din over it, that he no longer gives the wooing call but those short quick squeaks with the tail jerking nervously over the body. Thus attracted the stronger male then comes forward and drives the weaker ones from the area by bites and chases. One such male chased another along the beam of the first floor with the result that the latter lost its hold and fell on the paved courtyard below. He was stunned for sometime, and then when he tried to go up the stairs he had literally to drag himself, one back leg having become limp.

On April 7, my pet Squirrel Junior littered for the first time, 2 in number, the gestation period being 42 days. During the first litter the teats are not as prominent as after subsequent litters, especially the upper two. Her nest is in the upper room in a basket hanging from a nail with a cot standing against it for her to reach it.

On April 13, just 6 days after mating, the instinct of nest-building has been awakened in Squirrel Senior. From her already built nest she takes out materials, rolls them into a ball, goes along the casing to a certain distance, returns to her almirah and her wooden box by the same route, and rearranges it as if building anew. It is a very interesting performance.

On May 3, 26 days after mating, I saw Squirrel Senior for the first time deliberately prevent one of her young, now 2 months and 8 days old, from entering the box where it was born. There were all females in this seventh litter, and now the one I have reared and the two reared by the mother play together in the courtyard, but at night each goes back to her respective sleeping quarters. One of the young has left the box but the other still occupies it. The mother was keeping watch on the almirah next to the door leading to the courtyard. As soon as the young one came on to it she chased it off and resumed her watch. The second time it came the mother attacked her, and losing her balance she fell on the floor. Not in the least ruffled the youngster went up the curtain, on to the Frigidaire and then into her box in the wall almirah, while the mother looked on stupefied at this short cut and successful occupation of the nest she had decided on for her coming litter.

On May 20, 1956, Squirrel Junior, whose first litter is one month and thirteen days old, mated for the second time and she herself just nine months old. Stray suitors had been following her for the last two days but she chased and drove them out of the room containing the nest, and went back to the cot where her young ones played after abandoning the basket. Squirrel Junior calls for her food by squeaking at the top of her voice to attract my attention as she feels uneasy to come down the stairs for fear of being caught and bitten unawares by Senior. On May 20, as I came out with her buttered toast I saw her surrounded by suitors. Once, as I was sitting on the ledge next to a hole for the passage for rain-water, the mating pair came out of the shelter in the process of mating and dragged along until they were just behind my *sari* to protect themselves from the sun, and remained there until another inquisitive squirrel came to investigate and forced them apart. With the setting sun there was just a young male in sight to whom Squirrel Junior eagerly went when he gave the love call, but when he came to mate he turned out to be immature, and try as he might he could give her no satisfaction. She would run about and come again and again to him and he would mate but with no result, until it became quite dark.

The same day, May 20, Squirrel Senior gave birth to her eighth litter, the gestation period coming to one month and twelve days. This is the second time she has left her regular nest to make another in the adjoining compound, the first time being last summer; but that litter she had brought back when the monsoon broke. This time she left for two reasons: because her seventh litter had occupied it for quite some time, and secondly, there was a fuse in the casing above the Frigidaire. When the repair was being done the man had been too near the almirah containing the box, and the mother was sitting at the other end of the casing watching the man. Since then she abandoned the almirah.

Each squirrel has such distinct characteristics that it surprises me when people put them all in one category and leave it at that. They are as different from one another as any two human beings. Squirrel Junior and the one I reared from the seventh litter just put their mouth to the milk and drink their fill without once raising their head, and then wipe the chin on the stone. Squirrel Senior takes each sip and with her right paw wipes the last drop from her chin and then cleans the paw with her tongue. This is her peculiarity and she does it after every sip, be it tea, milk, or coffee.

Their tastes differ as well. Senior accepts wheat flour kneaded in water during gestation period only, Squirrel Junior never. They both love bread but it must be toasted and liberally buttered; the youngest refuses to touch it. They have a common liking for orange slices, pistachio, and monkey-nuts and, of course, any insect barring ants, dead or alive, they just relish. Once I saw Squirrel Senior rush and catch an adult locust and at another time watched her capture a praying mantis, and quite a specimen it was, and all that was left of both were the wings and the prickly legs.

On July 2, while I was on my way to the station I was conscious of a commotion and then saw a retinue of suitors following my pet Squirrel Senior. Her last litter is one month and fourteen days.

Previous to that I had been away for a month so that I had missed the exact date when conception took place of Squirrel Junior. There must have been an unfortunate accident to her litter which should have arrived on June 30, since she had mated on May 20. Then a month usually elapses between the arrival of one litter and the conception for the next. As I said I was away so I cannot say how the litter was destroyed, but it certainly was, or how can I account for the discovery I made on August 16, 1956.

My father came down that morning and asked me to go up to his room and turn the bed as there was a squirrel's nest by the pillow. Naturally I was scandalized, and shamefacedly went up and turned over the mattress, and imagine my surprise when I saw between it and the cot, not only quite a large nest but all in the game were three baby squirrels! The canvas of the cot had been neatly cut and cotton-wool from the mattress had been liberally used to line the nest.

The upper surface of the mattress, the bed sheet, and even the mosquito net had not been touched. In case the weight of the body pressed on the nest the mother had been careful to build the nest next to the space occupied by the pillow.

Gently I took out the whole nest along with the young ones, all as red and hairless as could be, barely two or three days old. The mother was nowhere near about. After some time she came, saw the nest, ate the biscuit I gave her, and then proceeded to investigate. The moment she saw her young she caught hold of it by the nape of the neck and went straight for the cot. Not finding the nest there she refused to come out. As I drove her out she left the young one in it and came out. Very carefully I took the young one out which then gave a squeak, and then the mother was frantically jumping all over me to get it back. Surprisingly she did not bite me, but as I put the youngster in her nest she caught hold of it and ran up the stairs. By the time I went up she had vanished.

I scanned for her far and near but there was no sign, and I was afraid that she would forget about the other two, and they would die of starvation since they were too young to be reared by hand. As I was sitting on the steps feeling despondent I saw her coming out of the ventilator. I was amazed at her intelligence. She stepped on one side of the ventilator and it opened, and as she went in it closed after her. Beyond was a ledge where she had hidden the young one she ran away with. In the meantime I went to investigate why she had left her previous nest to make a second in the cot because they usually like to bring up consecutive litters in the same nest as Squirrel Senior is doing. I found the cot that stood for her staircase had been removed during summer for guests to sleep in the open. I put up the framework of a cot against the basket for Squirrel Junior to go back to her old nest if I could pursuade her.

Losing my patience waiting for her to come for the two young ones in the box, I took one out and immediately it gave a soft squeak, hearing which the mother ran out helter-skelter. She came directly to my open palm, caught the young one by the nape of the neck and, because I was too near the ventilator, went straight to her old nest in the basket. They have a remarkable memory. As regards counting the litter they are no good. If two are removed behind the mother's back they are none the wiser, but let the mother see you in the process of removing and she becomes well-nigh frantic. Squirrel Junior was happy with one, forgetting the one on the ledge and the third still in the box. The moment I brought it out and it squeaked, the mother remembered and without the least effort to bite me took it back to her nest. Seeing her quite oblivious of the youngster on the ledge I had it taken down by ladder all covered with dust and took it up to the mother, who graciously came and took it back but only when I managed to make it squeak. Junior has the sweetest of tempers. Compared to her, Squirrel Senior is a perfect volcano. I give her wide berth when she has a litter, and even when I feed her outside the almirah I have to be on guard, as she is always on the look-out for opportunities to come and nip me, and rather sharp ones too.

On August 14, Squirrel Senior has given birth to her ninth litter, and for the first time of four. The gestation period was 1 month and 12 days. I have seldom seen such a possessive squirrel as Senior. Both Junior and Senior have for the first time littered together and one can quite understand their hunger. Squirrel Senior will not allow Junior the hospitality of the house. The way she gives chase would have forced any other squirrel to leave the territory for good, but Junior is made of sterner stuff. Driven by hunger she takes every opportunity to slip in to be fed unnoticed, and the moment she glimpses Senior she flies up the stairs followed closely by her enemy clucking and snapping viciously at the heels. The very next moment Junior comes down the stairs by a round-about way to renew her unfinished dinner, while Senior continues searching for her.

The young one I took from the 7th litter to bring up, Senior managed to drive out of the house as she is very much against sharing her territory with another, be it one of her own litter or a foundling as is Squirrel Junior. Today (September 4, 1956) as I write, I shall take out and rear one from the ninth litter, now three weeks old. In case I succeed in keeping this third female within the vicinity, I hope to record a comparative study.

Postscript: I had been away for over a couple of months so that I cannot say when the next conception or when delivery took place, but when I came back on November 19, 1956, I found a litter of 3 in the box in the almirah belonging to Squirrel Senior. They looked quite 10 days old, this her tenth litter.

This time, as with the previous litter, the mother found a new way of ridding the nest of her young. Just before they became unwieldy, say at 45 days old, she took them out one by one by the nape of the neck up the stairs to a room above where they were safe from human curiosity!

On January 6, 1957 Squirrel Senior has mated for the eleventh time in her young life of three years and three months. She is already the mother of 24, not counting her first litter that met with tragedy.

SUMMARY

The observations I have so far recorded show that female squirrels reach maturity between 6 and 8 months. They take the initiative in advertising to the squirrel world their presence and willingness to be wooed. The males commence the onslaught with frequent calls, each having a fair chance of mating with a female once. They come for a day only, and it is the female alone that makes the nest and rears her young. The gestation period is on an average between 40 and 42 days. The young are born blind and hairless, but the markings are faintly present. There are usually three litters in the year, with an average of 3 young per litter. Two and four young in a litter are rare. One and five I have never come across. The teats are 4 in number. During the suckling period, which lasts for nearly 2 months, the mother spurns male attention.

THE SHIPWORMS OF SOUTH INDIA WITH A NOTE ON THE BREEDING SEASON OF *BANKIA INDICA* NAIR

BY

N. BALAKRISHNAN NAIR, Ph.D.

Department of Zoology, Alagappa College, Karaikudi

(*With a plate, three text figures, and a graph*)

INTRODUCTION

The importance of the preservation of timber structures against the attack of marine borers has been recognised in India only very recently. While the teredines of Europe, Australia, the Pacific Islands, and the New World are well known, and we possess a vast body of information about the taxonomy of these molluscs through the papers of Jeffrey (1860), Wright (1865), Hedley (1901), Calman (1919), Bartsch (1921, 1922, 1923, 1927), Miller (1924), Lamy (1927), Sivickis (1928), Moll and Roch (1931, 1937), Iredale *et al.* (1932), Edmondson (1942, 1946), no serious attention has been paid to a systematic study of the shipworms of the Indian waters. Our present knowledge of the shipworms of India is due mainly to the contributions of Erlanson (1936), Roonwal (1954), Ganapati and Nagabhushanam (1955), and Palekar and Bal (1955), but none of these authors have made any exhaustive investigations into the taxonomy, anatomy, or physiology of these borers. In spite of the Indian coast-line of about 3,000 miles and a continental shelf of more than 100,000 square miles, and dependence on wooden country log-rafts and dug-out canoes for fishing operations, and timber for marine construction, it is strange that so little is known regarding these marine borers which cause immense economic loss to underwater wooden structures all along the sea-front. A taxonomic survey of the shipworms was, therefore, undertaken during 1953, especially as it would serve as a foundation for further work. The information presented in the following pages represents the results of an attempt to investigate the biology of these borers in the Indian waters as a preliminary to further investigations. It is most likely to help persons interested in the depredations by marine borers and to be of importance to industries and persons who have interest in local waterfront structures.

In order to procure specimens of as many of the existing species of borers as possible, and information as to their relative and actual importance and period of activity, different types of timbers such as drift logs, floating seeds, underwater wooden structures like piles, wharves, floating fenders, hulls of boats, and catamarans, were carefully examined. Further, a system of test planks were submerged in selected sites in the sea for the procurement of material for the study.

The teredines collected by the author from the South Indian waters are listed below on the basis of the classification used by Bartsch (1922).

LIST OF SHIPWORMS COLLECTED FROM SOUTH INDIA[1]

Genus **Bankia** Gray

1. *Bankia* (*Bankia*) *bengalensis* Nair
2. *Bankia* (*Bankia*) *bipalmulata* Lamarck

Sub-genus BANKIELLA Bartsch

3. *Bankia* (*Bankiella*) *indica* Nair
4. *Bankia* (*Bankiella*) *edmondsoni* Nair

Sub-genus NEOBANKIA Bartsch

5. *Bankia* (*Neobankia*) *lineata* Nair

Sub-genus NAUSITORA Bartsch

6. *Bankia* (*Nausitora*) *madrasensis* Nair
7. *Bankia* (*Nausitora*) *gabrieli* Nair

Genus **Teredo** Linnaeus

8. *Teredo* (*Teredo*) *madrasensis* Nair
9. *Teredo* (*Teredo*) *parksi* Bartsch
10. *Teredo* (*Teredo*) *furcillatus* Miller
11. *Teredo* (*Teredo*) *indica* Nair
12. *Teredo* (*Teredo*) *navalis* Linnaeus

Sub-genus TEREDORA Bartsch

13. *Teredo* (*Teredora*) *gregoryi* Dall *et al.*
14. *Teredo* (*Teredora*) *clava* Gmelin
15. *Teredo* (*Teredora*) *rehderi* Nair
16. *Teredo* (*Teredora*) *minoris* Nair

Sub-genus ZOPOTEREDO Bartsch

17. *Teredo* (*Zopoteredo*) *bengalensis* Nair

Sub-genus TEREDOTHYRA Bartsch

18. *Teredo* (*Teredothyra*) *linearis* Nair

The information regarding the distribution of the species along the Indian coast, the relative amount of damage of which the different species are capable, and the ecological conditions under which they live is very scanty. Such knowledge is necessary in order that possible attack may be predicted and prevented, or actual attack reduced in intensity or altogether stopped. There also seemed to be little information available regarding the food requirements of these borers, and still less about their breeding habits and development.

During the course of the systematic study, the author found that there are different species of borers infesting the same type of timber, as well as a single species infesting different types of timber (Nair, 1956). *Bankia indica*, the commonest form found in the clear off-shore waters of Madras, was found to attack mainly red cedar (*Cedrela*) and *Melia composita*. *Teredo gregoryi* and *Teredo madrasensis* rank second and third in abundance and degree of destruction, and attack a wider range of timber *Cedrela toona*, *Terminalia* sp., *Aegle marmelos*. On the west coast it was found that piers and jetties made of teak (*Tectona grandis*), coco-nut stems (*Cocos nucifera*), and mango wood (*Mangifera indica*) are affected by *Bankia* (*Nausitora*) *gabrieli* and *Teredo navalis*. *Teredo navalis* was obtained in large numbers from parts of discarded country canoes of *Thespesia* in the Pulicat Lake and from the turtle cages of *Borassus flabellifer* in Tondi. The more important forms collected from Madras harbour were *Teredo madrasensis*, *Teredo furcillatus*, *Teredo indica*, and *Teredo parksi*, chiefly from underwater timber structures, and with the help of test panels of *Myristica* sp. *Teredo clava* was collected from the floating corky seeds of the mangrove *Carapa* sp. *Teredo rehderi* was found infesting *Mangifera indica*, *Bursera* sp., and also from drifting bamboo poles. *Bankia lineata* was obtained in large numbers from floating logs washed ashore on Madras beach during the monsoon times. (Plate, photo 1.)

---

[1] A detailed account of this is in the course of publication in *Records of the Indian Museum.*

THE RESISTANCE OF UNTREATED TIMBERS TO MARINE BORER ATTACK

From an examination of 16 species of timbers belonging to eleven families, Nair (1956*a*) observed that green sections without exception offered more resistance to marine borers than did dry ones. It was also noticed that barks of timbers offer considerable protection against these pests. Of the 16 species studied, only very few showed any notable resistance and the majority showed no promise of any resistance at all. Coco-nut and palmyra stems showed considerable powers of resistance for the first 12 months and teak for 6 months of the experiment. Hence, untreated coco-nut and palmyra stems, as well as teak wood, assure their usefulness for sea-water exposures for some months at least, and even for longer duration if properly treated.

The exact factor which serves as the security against marine borers is not properly understood. It has been shown that presence in appreciable amounts of silica, alkaloids, oils, acids, and resins can inhibit the activity of the borers (Edmondson, 1955).

THE MARINE GROWTHS AND THEIR EFFECTS ON BORER ATTACK

During the course of the study, the effect of marine growths on the attachment of borer larvae was studied. It was observed that undisturbed marine growth retarded larval infestation with a consequent effect on the development of borer destruction. It is probable that the barnacles, polyzoans, tunicates, and the mussels found in large numbers on the test panels, when alive would consume great quantities of the larvae as part of their planktonic diet. The barnacles provide calcareous bases, which adhere to the timber so closely that they prevent outside penetration into the areas they cover,

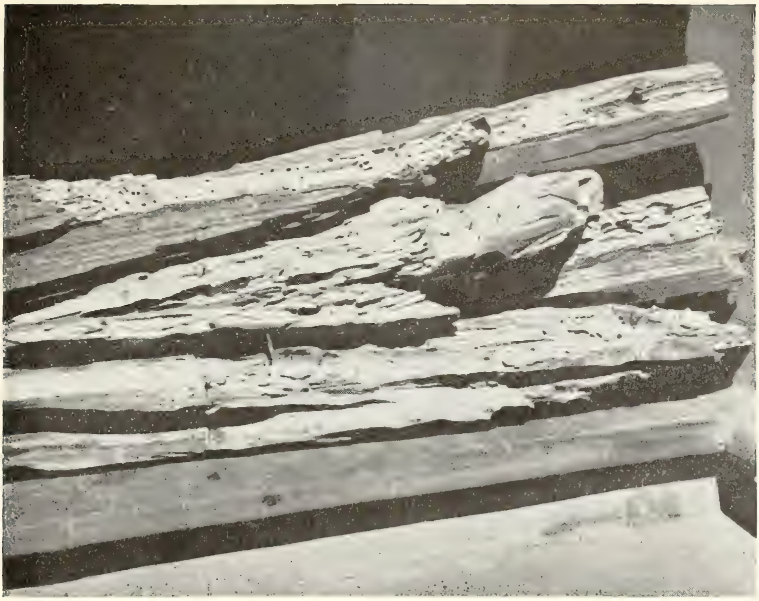


Photo 1. Experimental test planks of *Cedrela* sp. showing the destruction caused by Shipworms.

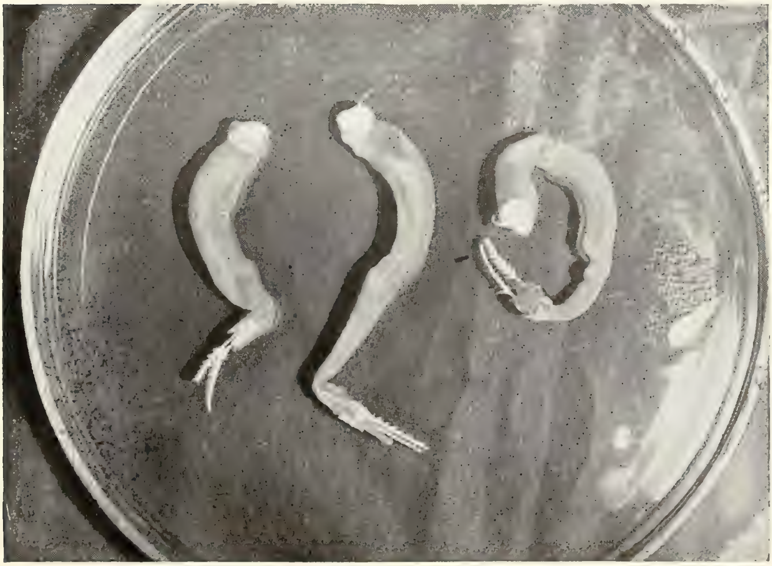


Photo 2. Three entire Shipworms (*Bankia indica*).

even after the death of the animal. The dense fleshy compound tunicates also probably can temporarily slow down the attack of borers.

Bankia indica Nair

GENERAL ORGANISATION OF THE BODY

The common shipworm *Bankia indica* occurring in large numbers on the fishing floats used in San Thome, Madras was studied in detail regarding the anatomy, sex changes, breeding season, development, and physiology of digestion.

Like other teredines, *Bankia indica* has a long, slender, cylindrical, and soft body. Covering only a small portion of the anterior end of the visceral mass, the irregularly-shaped shell functions as the main organ for the excavation of the burrow, and accommodates within it only the discoidal foot, anterior part of the alimentary canal, and the adductor muscles. The shell valves when in contact gape widely in front and behind for the projection of the foot and extension of the body respectively. The edges of the shell are not brought together, because of the modified contact on the dorsal and ventral articulations. (Fig. 2.)

The general arrangement of the organs in *Bankia indica* as seen from the right side when the shell and mantle are removed is shown in figure 1. Due to the lengthening of the body, the visceral mass occupies approximately a third of the body while the ribbon-like posterior part of the ctenidium extends from the visceral mass to the base of the siphons. Most of the organs lie behind the posterior adductor muscle instead of anterior to it as in most lamellibranchs. (Fig. 1.)

The shell valves are irregular in outline. The anterior regions are sculptured with sharp denticles whereas the posterior part is comparatively smooth. The details are shown in figure 2.

Pallets are peculiar structures which occur at the base of the siphons on either side beneath the muscular collar of all the shipworms. In *Bankia indica*, when the two pallets are pressed against each other their semi-circular outer surfaces form a complete conical plug, with which they can effectively close the circular opening of the burrow. If the salinity of the sea water should considerably change, or if poisons are introduced or the timber is taken out of water, the pallets are thrust into the opening, closing the burrow as a shield protecting the soft animal inside.

The Adductor Muscles: The adductor muscles are very highly modified. In cross-section the posterior adductor is about 11 times larger in area than the anterior adductor. From their position and attachment on the valves it is evident that these two muscles instead of contracting simultaneously as in typical dimyarians do so alternately, drawing together the front and hind parts of the shell valves causing the two valves to swing upon each other back and forth on the pivot formed by the dorsal and ventral knobs. This type of movement helps in boring. The large size and mode

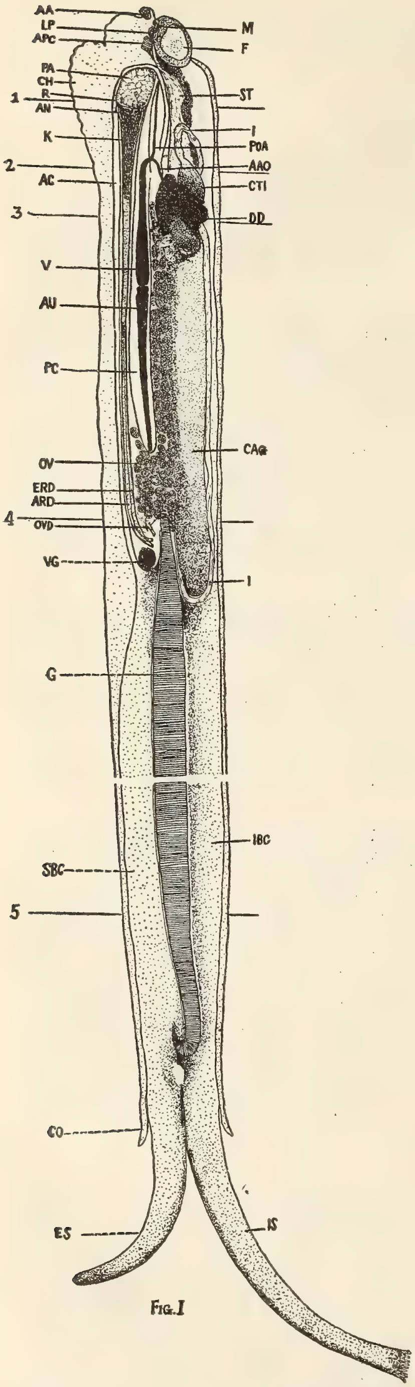

AA
LP
APC
PA
CH
R
1
AN
K
2
AC
3
V
AU
PC
OV
ERD
ARD
4
OVD
VG
G
SBC
5
CO
ES
M
F
ST
I
POA
AAO
CTI
DD
CAG
I
IBC
IS

FIG. I

Key to the Lettering of Figure.

AA	Anterior adductor.
AAO	Anterior aorta.
AC	Anal canal.
AN	Anus.
APC	Anterior part of the ctenidium.
ARD	Afferent renal duct.
AU	Auricle of the heart.
CAG	Caecum of the stomach.
CH	Cephalic hood.
CO	Collar of the mantle.
CTI	Coiled typhlosole of the intestine.
DD	Digestive diverticula.
ERD	Efferent renal duct.
ES	Exhalant siphon.
F	Foot.
G	Gill.
I	Intestine.
IS	Inhalant siphon.
K	Kidney.
LP	Labial palp.
M	Mouth.
OV	Ovary.
OVD	Oviduct.
PA	Posterior adductor.
PC	Pericardium.
POA	Posterior aorta.
R	Rectum.
SBC	Suprabranchial cavity.
ST	Stomach.
V	Ventricle.
VG	Visceral ganglion.

FIG. 1. The general arrangement of the organs in *Bankia indica* as seen from the right side.

of attachment of the posterior adductor suggest that the valves can be brought together at the anterior end, and that its vigorous adduction is responsible for the powerful outward thrust of the anterior part of the shell valves. The divarication of the denticulated front ends is of significance in the boring operations, the relatively feeble adduction through the contraction of the anterior adductor being sufficient to bring back the shell to normal position.

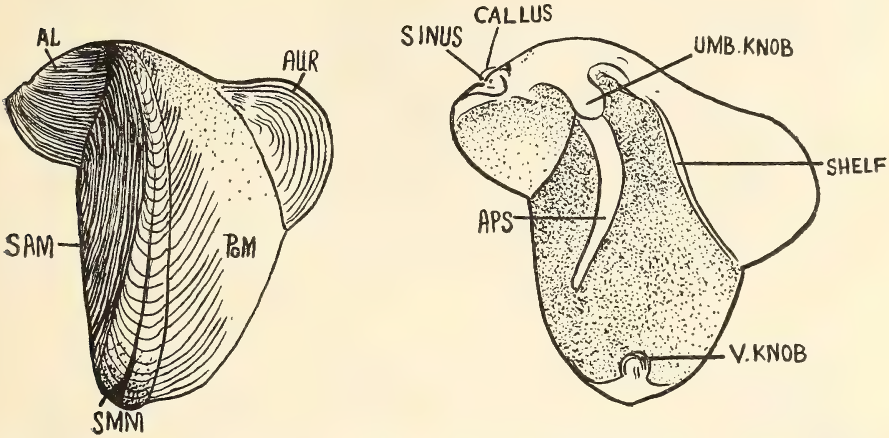


FIG. 2. Outer and inner views of the shell of *Bankia indica.*

Key to the Lettering of Figures.

AL	Anterior lobe.
AUR	Auricle of shell.
APS	Blade.
POM	Posterior median lobe.
SAM	Anterior median lobe.
SMM	Middle median lobe.

The Foot: The foot of *Bankia indica* is short and cylindrical, and is situated at the extreme anterior end of the visceral mass ventral to the mouth. This organ serves to grip at the burrowing end, while the shell is rotated round this point of attachment during the drilling process. The front surface of the foot which is thus applied to the wood is cordate in outline with a smooth central disc-like area or 'sole' bounded by elevated, wrinkled, peripheral, glandular margins, which are ciliated and thrown into folds. This shape and structure are quite in keeping with its habit of using this organ for attachment.

The Boring Mechanism: The foot of this pelecypod illustrates how plastic the organic body proves when an animal adopts an entirely new habit. It is so specialised that it is just a sub-circular disc with pedal muscles of other lamellibranchs modified for assisting in boring into wood. There has been much discussion as to whether these animals do this boring by mechanical or chemical means or a combination of both. Notwithstanding the correct suggestion of Home that the foot adheres to the wood acting as a centre-bit while the animal is boring with the shell, there have been repeated claims that the foot is directly concerned with the boring activities (Jeffreys, 1865; Hedley 1901; Kuhlman, 1914). These authors considered that the shell effects a grip on the sides of the burrow supporting the foot against the wood. A study of the histological structure of the organ in *Bankia indica,* as well as observation of this organ in the living specimens, lead the present author to conclude that its primary function is to effect a cupping action at the end of the burrow to hold the shell in position while boring. The peripheral wrinkled region with its ciliary covering helps to conduct the grated particles of wood to the mouth. The unique shape of the shell, its elaborate denticulations, the development of additional faces such as the posterior lobe for the insertion of the posterior adductor muscle, the acquisition of secondary articulations to achieve a special type of movement, the loss of the hinge teeth, the reduction of the ligament, and the histological peculiarities of the shell suggest that the shell

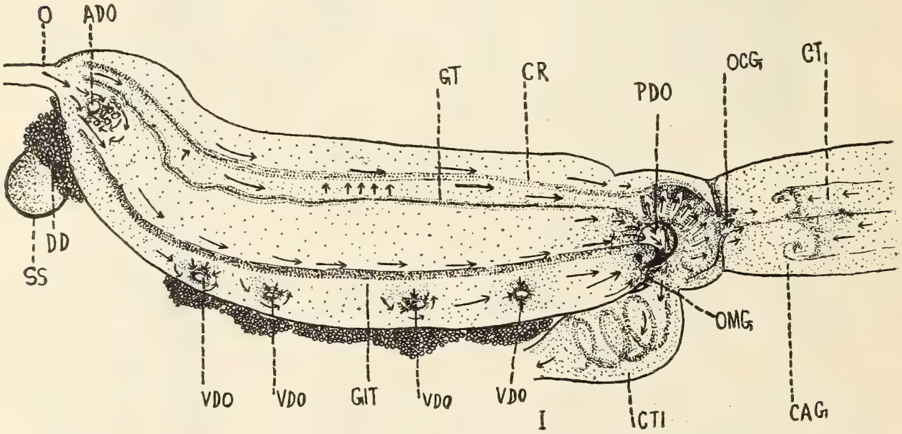


Fig. 3. Diagrammatic sketch of the stomach and caecum showing the ciliary currents.

Key to the Lettering of Figure.

ADO	Anterior openings of the digestive diverticula.
CAG	Caecum of the stomach.
CR	Ciliated ridge.
CT	Coiled typhlosole.
CTI	Coiled typhlosole of the intestine.
DD	Digestive diverticula.
GIT	Gastro-intestinal typhlosole.
GT	Gastric typhlosole.
O	Oesophagus.
OCG	Opening of the stomach into the caecum.
OMG	Opening of the stomach into the intestine.
PDO	Posterior opening.
SS	Style sac.
VDO	Ventral openings of the diverticula.

in *Bankia* has a specific function to perform. When one considers that the shell in these forms is not only a boring organ but a feeding organ as well, Hedley's suggestion (1901) that the shell in Teredinidae is degenerate and the next step would be its complete disappearance sounds strange. It is true that the shell has lost its protective character, but in this specialised bivalve in which protection is afforded by the nacre-lined burrow the shell is assigned the role of scraping such fine particles of wood as will be easy to feed upon, and the form both of the foot and shell suggest a long specialised evolution. The pronounced development of the posterior adductor, its fibres being suited for powerful and frequent contractions, its insertions being adapted for facilitating powerful outward thrust of the denticulated regions of the shell valves, indicates that this muscle is part of a mechanism which has been perfected as a whole. It is obvious that no one organ can be elaborated or simplified without the other organs associated with it undergoing appropriate changes. One is inclined to wonder whether such a complex mechanical pattern can be produced by just an opportune gene pattern or by the gradual addition of details of structure.

The Alimentary Canal: The stomach of *Bankia indica* bears five distinct kinds of diverticula, the caecum, the sac of the crystalline style, the dorsal caecum, the lateral pouch, and the digestive diverticula. The caecum is a long cylindrical, non-ciliated, blind tube extending from the stomach, and forms the largest part of the alimentary canal. This organ is usually filled with wood particles and its ventral wall is infolded to form a two coiled typhlosole extending through the entire length. The free edge of the typhlosole is further rolled up, considerably increasing the internal surface area of the caecum. The wood particles held between the folds of this typhlosole are found in a state of dissolution, suggesting that a certain amount of digestion of wood takes place in the caecum. The crystalline style sac is pyriform and opens into the stomach at its left side on the anterior end. It contains the crystalline style, which is a gelatinous flexible body of a glassy transparency, shaped like a club. The style of this form is smaller than those of *Martesia* and *Mya*. Since the style matter is continuously added on, the style was found intact, retaining its bulk in all specimens, assisting both in digestion by the liberation of the enzymes as well as in the mechanical process of pushing the particles of wood into the stomach. The gastric shield, which in other bivalves functions as a protective shield against the abrasive action of the tip of the rotating style, covers only a very small area of the stomach wall. The dorsal caecum is an outpocketing of the anterior, dorsal wall of the left side of the stomach. Since this sac also is filled with particles of wood, it is probable that it serves as a receptacle for large particles of wood, too many of which would block the proximal region of the stomach and impede normal functioning. The lateral pouch is a distinct outpocketing of the stomach wall in between the dorsal caecum and the sac of the crystalline style. Since the wall of this pouch shows several muscle fibres it is probable that this sac by its pulsations aids in the movement of food in the stomach. The digestive diverticula are composed of numerous blind tubules and occupy the ventral region and posterior side of stomach and also extend into the foot and communicate with the stomach by ducts. Those of the posterior side are by far the largest and are distinguishable into a large more dorsal right half and a small left half. The right part is brownish green and lies on the right side of the posterior part of the stomach, while the left part is fawn-coloured, composed of few tubules and containing particles of wood. The ducts being lined by ciliated epithelium help the movement of particles. These facts and the presence of wood particles in the fawn-coloured region lead to the inference that this region of the digestive diverticula serves as a place where wood can be received and acted upon by enzymes.

Even though the essential food-collecting mechanism of the gills is represented and functions as in typical lamellibranchs, the enormous development of the caecum and the attenuation of the branchial groove into a passage of such a length and narrow diameter that the food particles that can travel along this to the mouth become limited in size and quantity. This involves such a rigorous elimination, that the major part of the plankton and suspended particles conveyed by the water currents have to be rejected as pseudofaeces. Thus the function the gill discharges as a region of reception of food in other lamellibranchs is minimised owing to the high specialisation towards the exploitation of the wood which they bore into as food. This accounts for the absence of plankton and diatoms in the alimentary canal. As a direct consequence of the specialisation towards a wood boring habit and a diet of wood particles, this mollusc has become so incapable of making full use of the water-borne planktonic food that, when the wood supply is exhausted, it becomes helpless eventhough it is equipped with enzymes which can digest carbohydrates, fats, and proteins, available from the plankton (Nair, 1955).

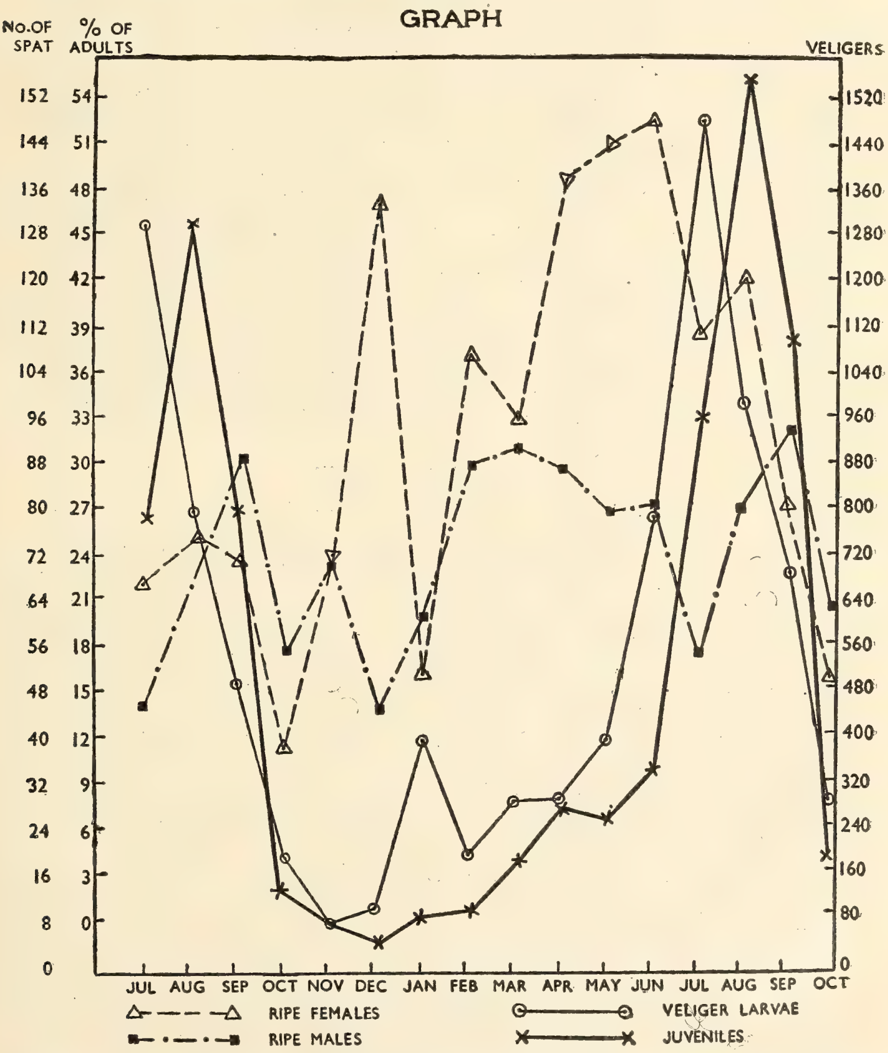
THE SEX CHANGES

Bankia indica is unique in the possession of a seminal receptacle closely connected with the reproductive organs. In these timber borers which live in floating wood and therefore form isolated communities, storage of sperms and their conservation will be of survival value.

Bankia indica is essentially protandric, nearly all females passing through a preliminary functional male phase before reaching the female phase. In view of the presence of a few spermatocytes in the cortical regions of the follicles, it is not improbable that the females after a functional spawning phase may revert to the male phase and produce spermatozoa.

THE BREEDING SEASON

During the course of the study, it was felt that an exact knowledge regarding the breeding season of *Bankia indica* will be of value to formulate means for the conservation of timber against their attack. In this boring pelecypod, as in many invertebrates of tropical seas, breeding appears to be continuous, marked by seasonal intensity. The frequency of the occurrence of larvae in plankton tow-netted in the in-shore area, the appearance of post-settled stages on test planks, as well as the condition of the gonads of adults studied during the different months support this conclusion.



GRAPH. Curves illustrating the occurrence of larval veligers in plankton, settlement of spat on test planks, and the condition of the adults in respective months.

TABLE

Table showing the gonadic condition of adult *Bankia indica*, the frequency of the occurrence of the larvae in plankton, and the number of post-settled stages on test planks in respective months.

Month	1 Veliger* larvae in plankton 500 cc..	2 Post-settled stage 2 cm. long from test panel 5′ × 4″ × 3½″	3 Percentage of adults from test panels of 5′ × 4″ × 3½″			
			Males		Females	
			Full	Spent	Full	Spent
July	1300	79	14·4	18·9	22·2	43·3
August	800	130	21·8	12·7	25·5	38·1
September	500	80	30·5	15·2	23·8	27·6
October	200	13	17·7	39·2	11·4	25·3
November	80	8	23·4	20·3	23·4	31·2
December	100	4	13·9	19·3	47·2	11·1
January	400	9	20·0	16·4	16·4	38·1
February	200	10	30·1	21·7	37·4	6·0
March	300	18	31·1	14·8	32·8	18·0
April	300	29	29·8	4·2	48·9	14·9
May	400	26	27·2	11·96	51·1	6·5
June	800	35	27·6	8 1	52·9	10·2
July	1 500	98	17·9	12·3	38·7	29·2
August	1 000	157	27·5	7·3	43·5	15·9
September	700	110	32·8	16·4	27·9	19·7
October	300	20	20·9	25·6	16·3	34·9
November	200	...	...	...	...	...
December	200	...	...	...	...	...
January	100	...	...	...	...	...
February	200	...	...	...	...	...
March	400	...	...	...	...	...

Frequency of Occurrence of Veligers in the Plankton: A total of 250 samples of plankton of an average volume of 500 c.c. each were examined during 1954 and 1955. Each fresh sample was shaken up allowing the heavy shelled larvae to settle to the bottom and the number of larvae occurring in an aliquot fraction of the sample was counted. The number occurring in the samples were averaged for each month (see column I, Table). A peak is noticed during July, followed by rapid decline through the next three months till it reaches a minimum count in November.

Occurrence of Post-settled stages: Sixteen test planks each measuring 5′ × 4″ × 3½″ were examined from July 1954 to October 1955 for post-settled stages (about 2 cm., long which it reaches within a month). These blocks which were anchored in the sea off San Thome at a distance of about three miles from the shore were removed each month and brought to the laboratory. The shipworms were carefully chiselled out and the number of juveniles noted. The post-settled stages were observed during all the months, but they were clearly more during the month of August than at other times as will be seen from column 2, Table.

---

* The veliger larvae represented in this column are those of *Bankia* sp. alone, with the following features: Shell-height more than shell-length, with a light brownish flush, valves equilateral, characteristically convex, with high, steeply-slanting, narrow 'shoulders', prominent knob-like umbones, and short, sharply-curved bases; well-spaced lines of growth present, especially towards the ventral margin where radial rays are also distinguishable; at the posterior end of the foot a transparent byssus thread is present.

Condition of the Adults: The gonads of 1287 adult shipworms collected from test planks in the course of sixteen months were examined by taking smears of all and sections of a few, to note those with ripe sexual products, those which have started discharge of sexual products, and those which have completely discharged them. In cases where ripe gonads were formed, artificial fertilisation proved that they are capable of starting normal development. The data collected and examined in percentages of males and females (rest being hermaphrodites) and represented in column 3 of Table show that breeding is continuous, with two peaks one in December and another in May-June.

The abundant occurrence of larvae and intensive settlement in July and August respectively show that this period is very conducive for larval development and settling. The other peak period of spawning in December is, however, not followed either by the presence in great numbers of larvae in the sea or by dense settling of the young on test planks, probably because of certain as yet very little known unfavourable environmental conditions.

THE DEVELOPMENT

Bankia indica is oviparous. Fertilisation is external and cleavage unequal. Gastrulation is mainly by epiboly and partly by invagination. The trochophore stage is reached within thirteen hours after fertilisation and swims about for nearly eight hours before it transforms into the early veliger. The typical veliger stage is reached on the fifteenth day when it has shell-valves, which are equilateral and characteristically convex, with high, steeply-slanting, narrow 'shoulders', prominent knob-like umbones, and short, sharply-curved bases.

These larvae are plagic, swimming actively and feeding on plankton. The larvae, when they are about seventeen days old, are ready for settling on wood. It was noticed that rough surfaces of the panels received more larvae than polished ones. It was interesting to note that if a suitable substratum is not available, this tropical borer can retain its larval organs and postpone metamorphosis into the adult and continue as a free-swimming larva for a number of days. Such a capacity to prolong the free-swimming period is of considerable survival value since it helps the larvae to cover a wide area in their search for their appropriate substratum, and since it increases the chances of their encountering a piece of wood on which they can settle and perpetuate the species (Nair, 1956*b*).

THE RATE OF GROWTH

Study of the rate of growth of *Bankia indica* in large test planks of red cedar for a period of 219 days shows that growth is very rapid in the first 90 days and thereafter becomes slackened, and the trend indicates the rate of growth becoming almost nil at the end of the eighth month.

It is suggested that the growth in length is impeded by the depletion of the woody material in the panel due to overcrowding. It is possible that if larger volumes of wood had been offered, the increase in length would have continued for a period longer than eight months.

THE DIGESTION OF WOOD

Studies on the physiology of digestion were carried out in great detail (Nair, 1955, 1955*a*, 1956*e*). These showed the presence of enzyme systems capable of digesting carbohydrates, proteins, and fats in the digestive diverticula and a carbohydrase system including a cellulase in the crystalline style. The shipworms which feed chiefly on wood have the power of hydrolysing the highly resistant cellulose, since a strong cellulase system is present in the crystalline style and digestive diverticula. Their capacity to elaborate cellulase in addition to other carbohydrases, proteases, and lipases is as much an adaptation to their peculiar diet as the modification of the alimentary canal, the shell, or the foot.

ACKNOWLEDGEMENTS

Thanks are due to Prof. C. P. Gnanamuthu for suggesting the problem, and for encouragement during the course of this work and to Dr. C. H. Edmondson of Bernice P. Bishop Museum, Honolulu, Hawaii, for various suggestions. I am thankful to Mr. O. N. Gurumani, M.A., for assistance in my work.

REFERENCES

Bartsch, P. (1921): *Proc. Biol. Soc. Wash.*, **34**: 25.
— — — (1922): *Bull. U.S. Nat. Mus.*, **122**: 1-51.
— — — (1923): *Proc. Biol. Soc. Wash.*, **36**: 95.
— — — (1927): *J. Siam Soc. Nat. Hist., Supplement*, **7**: 59.
Calman, W. T. (1919): *Brit. Mus. (Nat. Hist.) Econ. Series*, **10**: 35.
Edmondson, C. H. (1942): *Occas. Pap. Bernice P. Bishop Mus.*, **17** (10): 35.
— — — (1946): *Occas. Pap. Bernice P. Bishop Mus.*, **15**: 211.
— — — (1955): *Bull. Bernice P. Bishop Mus.*, **217**: 1.
Erlanson, E. W. (1936): *Curr. Sci.*, **4**: 726.
Ganapathy, P. N. and Nagabushanam, R. (1955): *J. of the Timber Dryers' and Preservers' Assn. of India*, **1** (1): 19-26.
Hedley, C. (1901): *Aust. Assn. for the Advancement of Science, Melbourne*, p. 237.
Iredale, T. (1932): Published by the Maritime Services Board of N. S. Wales: 1-148.
Jeffreys, J. G. (1860): *Brit. Assoc. Adv. Sci. Rept., 30th meeting Trans.*, **117**.
— — — (1865): *ibid.*, **3**: 393.

[1] Kuhlmann, E. (1914): Über das Bohren der Muscheln Prometheus, **25**: 360.
Lamy, E. (1927): *J. Conchyliol,* **70** (4): 201.
Miller, R. C. (1924): *Univ. Calif. Pub. Zool.,* **26**: 41.
Moll, F. and Roch, F. (1931): *Proc. Malac. Soc., London,* **19** (4): 201.
— — — (1937): *Mitt. Zool. Mus., Berlin,* **22**: 161.
Nair, N. Balakrishnan (1955): *Curr. Sci.,* **24**: 126.
— — — (1954): *Rec. Indian Mus.,* **52** (2-4): 387-414.
— — — (1955*a*): *Curr. Sci.,* **24**: 201.
— — — (1955*b*): *J. Madras Univ.,* **24**: 109.
— — — (1555*c*): *Rec. Indian Mus.,* **53**: (1-2).
— — — (1556). *J. Sci. Industr. Res.,* **15c. 3**: 81.
— — — (1556*a*). *J. Sci. Industr. Res.,* **15c. 12**: 282.
— — — (1956*b*): *J. Madras Univ.* B. *vol.,* **26,** No. 2.
— — — (1957): *J. Sci. Industr. Res.,* **16c. 2**: 39.
Palekar and Bal (1955): *JBNHS,* **53** (2): 201-204.
Roonwal, M. L. (1954): *Proc. Zool. Soc. of Bengal,* **7** (2): 91.
Sivickis, P. B. (1928): *Philippine J. Sci. Manila,* **37**: 285.
Wright (1865): *Trans. Linn. Soc.,* **25**: 561.

---

[1] Not referred to in original.

THE ABOMINABLE SNOWMAN

BY

SWAMI PRANAVANANDA, F.R.G.S.

During the last ten years sensational news, stories, and legends regarding the 'Abominable Snowman', from the lay public as well as from Himalayan expeditionists, have become a feature in the press. On a close examination of these pieces of information, articles, etc., it seems remarkable that there has hardly been a single person who has actually seen one of these creatures or got reliable first-hand knowledge of the same, devoid of legend or exaggeration. Added to this, confusion is worse confounded by the fact that different persons have translated differently, and sometimes grossly mistranslated, the original Tibetan words designating or describing this animal, used by local inhabitants (Tibetans) who, from all accounts, could be presumed to have a more intimate knowledge of this creature than others. For example, the Tibetan expression *mi-te* has been rendered as 'abominable' by Lt.-Col. Howard Bury of the Everest reconnaissance party.[1] Really, however, the Tibetan word *mi-te* connotes *'man-bear'*. I heard of the *mi-te* for the first time in August 1935 when I was up at Thugolho gompa (monastery), on the southern shores of the sacred Lake Manasarovar, western Tibet, to select a site for my twelve-month sojourn in that region.

A Tibetan *dokpa* (shepherd) pilgrim from Markham (eastern Province of Tibet) was describing an incident how one of the sheep of his flock was attacked by a *mi-te* at the Kyang Chhu (16,000 ft.), a tributary of the Tamchok Khambab (Brahmaputra). It was dusk time when the dogs began to bark violently. The *dokpas* spotted an animal, which at first sight they thought to be a *changu* (wolf) and immediately fired two shots at the beast with their matchlock guns (literally flintlocks). Both shots missed the target; the animal left the sheep dead and bleeding and ran away. The shepherds saw the creature from a distance af about 100 cubits (50 yards). The animal at first ran on all fours, but after running for some distance it stood up on its hind legs to look back at the place from which the shots came. Seeing a number of men standing together, it disappeared into the upper portions of the valley, walking on its hind legs. The animal was described to be the height of a man and light red or reddish brown in colour. They called it *mi-tre*.

Again, in the month of June 1957, I heard of the *mi-te* for the second time, when I was camping at the traditional source of the

---

[1] But from the 'Gleaning' published on p. 509 of Vol. 53 (April 1956) it will be seen that Col. Howard Bury's original report of the 'Abominable Snowman' was not intended 'to be taken too seriously'!—EDS.

Tamchok Khambab or the Brahmaputra. A number of *nyakora* (pilgrim) nomads from Bongba and Amdo Province in northern Tibet, on their way to Lake Manasarovar and Kailas, were camping on the banks of the Brahmaputra, four miles below its source. They had gone there to try their luck if they could get a *dong* (wild yak) for a change in their meat. During the course of talk they told me that the source regions of Tamchok Khambab (Brahmaputra) and Kubi Tsangpo abound in wild yak (*dong*), Tibetan gazelle (*goa*), wild sheep (*na* and *nyan*), Tibetan antelope (*cho*), and lynx (*yi*). Incidentally they also told me that they had seen a *mi-te* in the source region of the Kubi (17,000 feet), one of the headstreams of the Brahmaputra. The *mi-te* or the red bear once attempted to attack one of their sheep, while they were grazing on the slopes of a mountain in a deep valley, but was scared away by a pack of watch dogs which began to fiercely bark at it. They further reported that the *mi-te* is found at several places on the Tibetan side of the Nepal border. This and the information gathered by me from other Tibetans go to show that the Tibetans know *mi-te* to be the red bear, one of the three varieties of bear familiar to them.

In my books 'Exploration in Tibet' (published by the Calcutta University) and 'Kailas-Manasarovar' I made mention of three varieties of bear known to the Tibetans, while describing the fauna of the Kailas-Manas region (pages 111 and 69 respectively): black bear (*tom*), brown bear (*te*), and man-bear (*mi-te*) (walks on hind legs like man).

In the word 'tre', the letter 'r' is so very lightly pronounced that it is almost inaudible. So, for all practical purposes I prefer to use the word as '*te*' only. I have not seen the *mi-te* myself, but collected this information from a number of local Tibetans, and from shepherds and pilgrims going to this region from eastern and central Tibet, contiguous with the Himalayas. Since the Abominable Snowman became such a prominent and sensational topic in the press in connection with almost all the Himalayan expeditions of the year 1950, I instructed some of my Tibetan friends in the Manas region to collect firsthand information by offering a substantial reward in cash. As a result of this I got the following information in July 1953. One *mi-te* visited the Tomo-mopo camp (15,000 ft.) on the Tag Tsangpo on the south-eastern side of Manasarovar. In February 1953, the *mi-te* passed that way in the evening. The shepherds camping at Tomo-mopo witnessed with great curiosity the animal moving in the Tag Valley, sometimes on all fours and sometimes on its two hind legs. At that part of the year the upper regions of the valley, and even the vast plains of the Tag Tsangpo, were under snow. It was perhaps for this reason that the animal came down so near the shepherd camps, obviously in search of food. Not finding an opportunity of snatching away any sheep since the shepherds were all alert, it disappeared into the upper region of the valley.

The following is the account given by my informant. The footprints of the *mi-te* left on the hard ground scantily covered by sand measured 16 fingers or 11 inches in length and 7 fingers or 5 inches in breadth. The 'feet' had 5 toes each and the 'hands' only 4 toes—at least only 4 could be seen in the imprints. In Tibetan, the front legs of an animal are called *lhakpa* or hands and the hind ones *kangba* or legs. The toes were two fingers or 1½ inches long; all the toes are almost of the same size, excepting the little toe which was a bit shorter than the rest. The animal when up on its hind legs was described as being a little taller than a tall man. The colour of the bear was deep brown, like that of the *ngaruserchung* (brahminy duck), though the shade varied from one part of the body to another. The body of the animal was covered with a thick coat of reddish brown hair and the hairs on the face were pretty long. Ten days after, when the shepherds had gone up the valley for grazing their sheep, they noted the footprints of the *mi-te* on the snow-fields to be about a cubit (18 inches) in length and correspondingly wide with no trace of the toes whatsoever. This, obviously, was due to the melting of the snow at the edges of the imprints and the consequent enlargement of the whole.

It was also reported that the *mi-te* sometimes attacks the yak and even man, when found alone. In the Manas region *mi-te* is found near about the sources of the Brahmaputra and the Kubi. Much like the wild yak, the *mi-te* often makes excursions into the snow fields and on to the glaciers.

Shrubs, grass, moss, rhubarb, *champa-estella* (*pang*), small plants, and flowers are found growing on either side of glaciers beginning from the snout right up to the head after the winter snows have melted. As a matter of fact, I have seen vegetation right up to an altitude of 20,000 feet or so. The question, therefore, does not arise as to what the *mi-te* or any other animal wandering in these regions may be after. I have actually seen wild asses and domesticated yaks digging snow with their hoofs and pushing aside sizeable stones with their noses for picking up grass and its roots.

It may be noted in this connection that the *mi-te* (red bear), like wild yak, kyang (Tibetan wild ass), lynx, snow leopard, wolf, ibex, bharal, ghural, Tibetan antelope, musk-deer, and other animals, often make excursions far on to the snow fields and glaciers, both during winter and at other seasons, in search of food and sometimes apparently for wandering's sake. So it is no wonder or a mystery that the footprints and tracks of these and other animals are seen on snow and glaciers, freshly made or old and distorted. As a matter of fact I actually saw, during my winter sojourns in Tibet during the years 1936-37 and 1943-44, tracks of wild yaks, wolves, and the other animals mentioned above for miles together. When the whole of the Manasarovar region was covered with heavy snow in winter, on two occasions a number of domestic yaks, belonging to the shepherds of Nonokur camping on the Tag, travelled on snow the whole night up to Selung Hurdung, a distance of 13 miles. Even as recently as 1 October 1954, when there was a heavy snow fall on Manasarovar, yaks from Riljen camp trekked on snow for seven long miles to Shushup Tso in search of grass. During my stay at Gangotri in the winter of 1934-1935 I saw the black bear wandering on snow. Also musk-deer and bharal were seen moving about leisurely and aimlessly on the vast expanse of snow round about the Gangotri Temple at midday.

Since the *mi-te* walks sometimes on all fours and sometimes on hind legs only, it is but natural that the tracks of footprints are sometimes seen in pairs and sometimes in single files.

When the footprints are observed after they have long been exposed to sun, it is no wonder that, due to the melting of the snow along the edges, the marks become enlarged to a length of nearly 18 inches with a corresponding width in case of the *mi-te*. Thus, Eric Shipton's footprints 'of the size of a young elephant's' could well be those of a lynx, snow leopard, or wolf, greatly magnified by the melting snow between the time they were made by the animal and the moment of observation. Footprints on the snow can be defaced, deformed, or decreased in dimensions, with the details of the finger marks etc. obliterated as a result of blizzards or by the blowing of strong winds.

When I was crossing the Khandosanglam Pass in 1941 I came across giant footprints as long as 21 inches. Khandosanglam is a pass east of Kailas peak. According to Tibetan traditions it could be negotiated only by those pious pilgrims who have completed twelve circumambulations of the Holy Kailas Peak by the regular Parikrama route. As such, hardly one or two pilgrims in a year negotiate this pass. My guide from Diraphuk gompa (second monastery of Kailas) informed me that a lama from Kham crossed the pass some twenty-five days before we did. The glacier was about a mile long and full of treacherous crevasses. The footprints left by my predecessor, the lama, on the deep snow had melted away a good deal along the edges by the warm sun of July, with the result that a trail of footprints, each 21 inches long with corresponding width, was before us when we were crossing the pass. A credulous or a superstitious pilgrim would have easily described the footprints as those of a great Himalayan Yogi a thousand years old, or of Asvatthama or Hanuman (one of the seven immortal *chirajivis*) of Mahabharata fame; they might as well have been described by some Himalayan expedition party as those of an 'Abominable Snowman' !

It may be recalled in this connection that Col. A. Waddell was the first Westerner to mark the footprints of the *mi-te* in 1899, in the north-east of Sikkim. Later, members of different Himalayan expeditions also noted similar footprints at heights ranging from 10,000 to 21,000 ft. above sea-level, in the Karakoram Range, Salween Valley in Burma, Kulu Valley, Garhwal, Nepal, Sikkim, Chumbi Valley, Bhutan, Assam, etc., and a few others in regions contiguous with Bhutan, Sikkim, and East Nepal on the Tibetan side. Much of the information regarding the origin of the footprints was, however, not firsthand, being based on hearsay, which in turn was a mixture of myth, legend, superstition, exaggeration, and imagination.

Let us now closely examine the real meaning of the Tibetan words used for the so-called Abominable Snowman. The following table indicates the different ways in which the expressions and words are translated by the various expeditionists:—

mi-te = abominable; filthy; disgusting to a repulsive degree; dirty.
miteh-kangmi = abominable snowman.
mih-teh = teh *par excellence* of the Sherpas.
me-te = man-bear.
me-tre = man-bear.
mih = man.
yeh-teh = rocky area-animal; animal which lives in a rocky area.
yeti = mi-te.
yite = mi-te.
kangmi = snowman.
gangmi = snowman.
mi-go = wild man.
mi-do = which goes like man; dangerous to man; man-bear.
mi-chempo = big man.
mi-bompo = strong man.
dzu-teh = livestock-animal; animal which is dangerous to livestock; red bear.
chhu-mung = water goblin.
lho-mung = mountain goblin.

The following are the correct meanings of the corresponding terms:—

mi mih me meh	= man.
te teh tre	= bear.
kang gang	= snow.

mi-gve, mi-go = beast that walks like man; these terms are used for snowman (man-bear) in Amdo and Kham Provinces of Tibet (now China); these terms are also used by or known to Tibetans on the Indian border adjoining the Province of Kham.
Yeh-da, Yih-da, Yeh-te, Yi-te—these terms are used for a mythological being with the throat as thin as a needle and stomach as big as a mountain; hence, a glutton; therefore, a contemptible being. Some people use these terms to 'mi-te' also; since due to ignorance of facts, they believe it, to be a dreaded creature.
tu-do, thu-do dhu-dho—a general term for a beast or a four-legged creature.
hlo-mung, lho-mung = wild witch or goblin.
chhu-mung = snow (literally water) goblin; since many have not actually seen the 'mi-te' or man-bear and since they consider the same to be a fearful or dreaded being connected with witchcraft, they wrongly dubbed the 'mi-te' or red bear as lho-mung or chhu-mung.

As a matter of fact, Tibetan words are pronounced with a wide range of sound, sometimes beyond recognition; for example:

t is pronounced as th, d, and dh,
k is pronounced as kh, g, and gh,
p is pronounced as ph, b, and bh, and so on.

It may be mentioned that these wild, exaggerated, false, snowman stories are heard mostly on the Indian and not on the Tibetan side. Very likely the first mistranslation made by Henry Newman in 1921 of the word 'meteh' (in meteh kangmi) as filthy, dirty, disgusting to a repulsive degree, hence abominable, may be responsible for the misconception which has prevailed ever since and misled others into repeating and perpetuating the mistake. Thirdly, the fact that the matter was not investigated thoroughly on the Tibetan side, where the local population have a correct knowledge of the identity of the animal and several persons have actually been eyewitnesses to it as the red bear, has helped the perpetuation of the wrong notion.

The terminology given above boils down to two expressions 'mi-te' and 'kang-mi', which respectively mean 'man-bear' and 'snowman'. These two terms connote the same object and they are the alternative terms used for the same animal, just as people call the orang-outang as bana-manas or wild man. On this score the so-called 'Abominable Snowman' is no other than the red bear of the Himalayas, the colour of the animal varying from light brown to reddish brown. The indisputable evidence from all sides points to this conclusion. All speculations, exaggeration, fanciful hypotheses, and fantastic stories and legends, believed or woven in this regard must be set at rest.

It is just possible that the 'te' (brown bear) and the 'mi-te" (man-bear or red bear) might be identical; or it may be that these two are confounded one for the other by the Tibetans on the Indian side of the Himalayas, and that it is the footprints of these animals that have been puzzling the brains of so many expeditionists, scientists, and laymen at large.

I have also got a report, not so far confirmed by a firsthand informant, that the 'te' and the 'mi-te' both go into hibernation under some rocks protected from wind, or in a cave, from the middle of November or December to the end of February, that getting up from hibernation they sometimes dig deep into the snow in search of grass and roots, and they sometimes make excursions on avalanches in spring for excavating the bodies of bharal, blue sheep, and gazelle, killed and buried under avalanches. I mention this here, as it may throw some light on the occurrence of the footprints of the *mi-te* in snow at high altitudes.

So far as my knowledge goes, the langur or the black-faced monkey of the Himalayas has never been seen wandering on snow, as it is seldom or never seen beyond the tree-line. As a matter of fact most of the langurs in the upper Himalayas are seen getting down to warmer regions much before the snowfall. So the footprints, resembling human footprints, observed on the snows by some of the Himalayan expeditionists could not be those of langurs.

Two years after the conquest of Everest and soon after my first article on the 'Abominable Snowman' appeared in the press, Sir Edmund Hillary opined that 'the snowman might be an unknown species of bear with super strength, but no man has ever seen it' [June 3, 1955]. And Sri Ten Zing still believes 'in the existence of "Yeti" or some queer animal', though he has never seen one.

Sri M. Lutroffle and Sri Pierre Bordet, French geologists exploring in the Makalu Range, still assert the existence (reality) of the snowman.

Dr. Charles Evans, leader of the British Kanchenjunga Expedition, says that in his opinion the mysterious yeti or Abominable Snowman is either a bear or a large sized monkey.

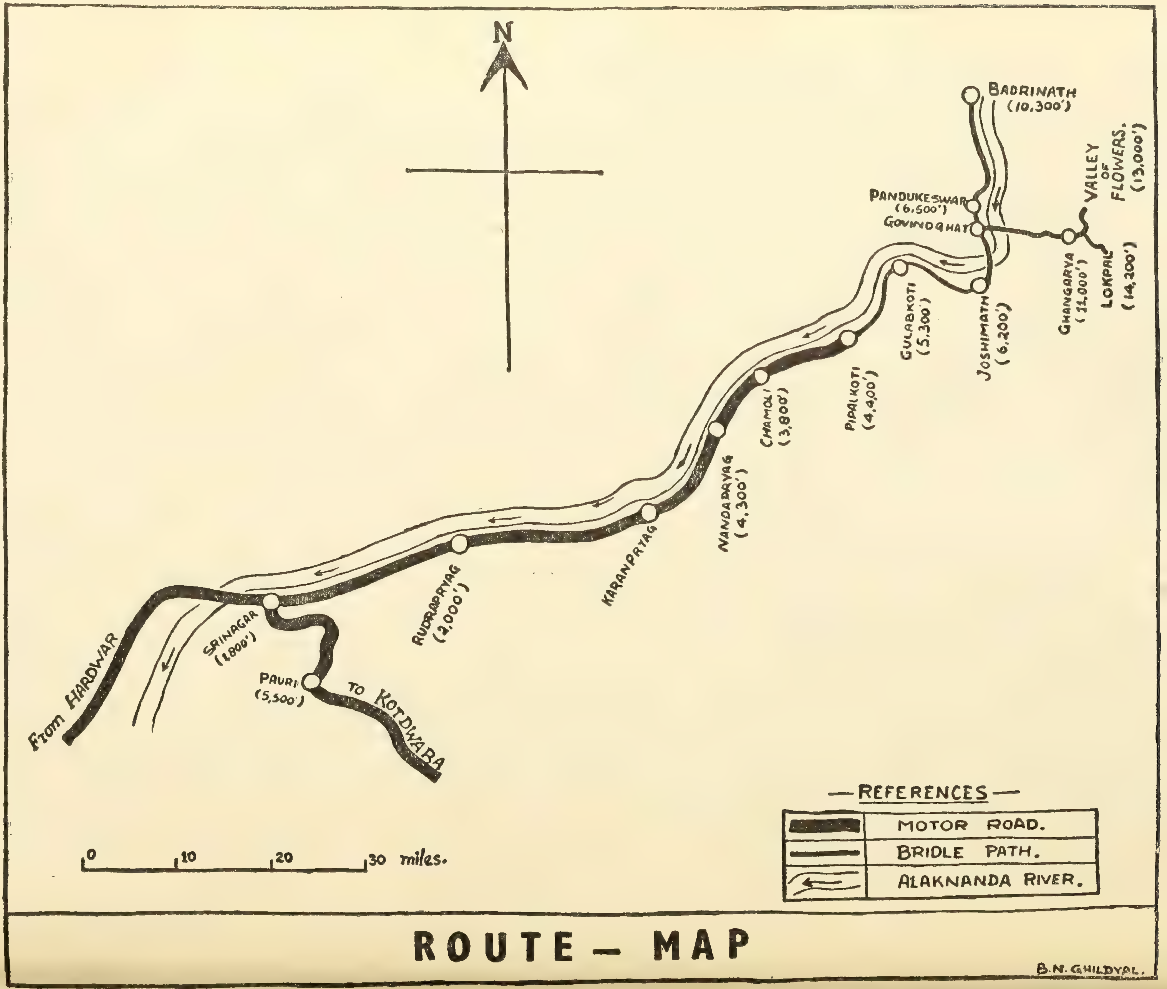
For years, the lamas of the famous Tyangboche (or Dangboche) monastery, situated in the Everest region, had been showing their special guests, the skull of an unknown animal as that of a 'yeti' or 'snowman'. Dr. Evans reverentially picked up two hairs from the said skull and sent them to the British Museum for examination. The experts' verdict was 'pig bristles'!

Dr. Strafford Mathews, member of the Kanchenjunga Reconnaisance, declared that the Abominable Snowman does not exist, and that it is an animal, and that it was nonsense to give opinion on the 'yeti', when you know that every bear has five toes (22-7-55).

Dr. Eggler, of 1956 Swiss expedition, does not believe in the existence of the 'yeti' and says: 'all the sherpas had heard stories of the yeti but none of them had seen one. No young man among the sherpas believes in the Snowman' (1-7-56).

Col. Huerta, leader of the Argentine expedition to Dhaulagiri, says that he did not believe in the existence of yeti and that he had always thought that the animal was nothing but a high altitude bear. He said that he did come across a bear, which he described as a 'living symbol of the yeti myth' during one of their base camp days, when they were out wild goat shooting at about 10,000 ft. He said that he had the animal killed by a Shikari to prove that the yeti was really a bear. The expedition's photographer, Mr. Bertone, had taken several photographs of the dead bear, which were available for any expert examination. It is cent per cent like an ordinary bear, a rough fellow with shaggy hair and hooked claws, Col. Huerta said.

A BOTANICAL TRIP TO THE VALLEY OF FLOWERS


N
BADRINATH (10,300')
VALLEY OF FLOWERS. (13,000')
PANDUKESWAR (6,500')
GOVINDGHAT
GHANGARYA (11,000')
LOKPAL (14,200')
JOSHIMATH (6,200')
GULABKOTI (5,300')
PIPALKOTI (4,400')
CHAMOLI (3,800')
NANDAPRYAG (4,300')
KARANPRYAG
RUDRAPRYAG (2,000')
SRINAGAR (1,800')
PAURI (5,500')
TO KOTDWARA
From HARDWAR
0
10
20
30 miles.
—REFERENCES—
MOTOR ROAD.
BRIDLE PATH.
ALAKNANDA RIVER.
ROUTE — MAP
B.N. GHILDYAL.

A BOTANICAL TRIP TO THE VALLEY OF FLOWERS

BY

B. N. GHILDYAL

Forest Research Institute, Dehra Dun

(*With a sketch map*)

INTRODUCTION

The beautiful Valley of Flowers has long remained enveloped in mystery, but a natural curiosity about this valley was excited by the writings of Mr. F. S. Smythe, leader of the Kamet expedition, who gazed upon it in 1931.

The valley is characterised by high altitude and uneven topography. It is situated at about 13,000 ft. above sea-level in the Garhwal District of Uttar Pradesh, and is about 2½ miles long and 1¼ miles broad. It is surrounded on three sides by permanent snow-capped mountains, and is open to some distance on one side. Locally the valley is variously called Bamnidhar, Kandolyasain, Bhyundhar Valley, and Valley of Flowers (Smythe, 1931). The significant features of the climate are long cold winters, deep snow, low mean temperature, and noticeable daily fluctuations of temperature.

Collections were made previously from this valley by R. Strachey and J. E. Winterbottom (1846-49), Smythe and Holdsworth (1931), Smythe (1937), and J. Legge (1939).

Curious to know about the flora of the Valley of Flowers, I visited this place in September 1955, starting from Srinagar, Garhwal, my home town.

SRINAGAR—PIPALKOTI

I left Srinagar on September 18, 1955 and reached Pipalkoti, the last bus terminus, on the same day. The valley here broadens out into terraces of cultivated fields, and the rest of the area looks bleak and bare except for a few scattered *Pinus roxburghii* trees. All along the valley of Alaknanda River there are a number of brooks, rivulets, streams, and small springs. There is a beautiful waterfall here. *Polygala abyssinica*, *Coleus barbatus*, *Nepeta spicata*, and Violas are commonly seen.

PIPALKOTI—JOSHIMATH

Left Pipalkoti early in the morning on 19 September and reached Joshimath after covering 18 miles on foot. The way from Gulabkoti (between Pipalkoti and Joshimath) to Joshimath passes through woods of *Pinus roxburghii*, *Quercus incana*, *Rhododendron arboreum*, *Pieris ovalifolia*, *Ilex dipyrena*, and *Myrica nagi*. *Peperomia reflexa* intermingled with moss is very common on rock layers or on *Quercus* *incana* bark. *Lactuca violaefolia* shows fine drooping violet bells. *Polygonum capitatum* with pink flowers in dense heads trail on rocks and rocky slopes. The beautiful shades of *Androsace lanuginosa* are very common on open slopes.

JOSHIMATH—BADRINATH

Next morning at about 6 a.m. I started for Badrinath. After a break of 3 hours at Pandukeswar I reached Badrinath at 5 p.m., covering again 18½ miles on foot. The path along the Alaknanda kept me alert all the time. The vegetation within the neighbouring places of the shrine has been completely destroyed by the inhabitants. It is a pleasant sight to see patches of *Rhododendron lepidotum*, *Morina longifolia*, *Allium stracheyi*, *Thalictrum reniformis*, and Asters. Occasionally patches of mushrooms and puff balls were seen in shady areas.

BADRINATH—VALLEY OF FLOWERS

After paying a visit to the sacred shrines of Badrinath, I left on 22nd September for the Valley of Flowers. I halted at a small chatti, Govindghat, 12 miles below Badrinath.

Next day I crossed the swinging bridge over Alaknanda River and reached Ghangarea (about 11,000 ft. above sea-level) after a gradual 10 mile ascent along the Bhyundhar stream. The path between Bhyundhar village and Ghangarea passes through *Corylus colurna* (Himalayan Hazel) and *Cotoneaster bacillaris* forest.

On this way there are two villages, Punn and Bhyundhar. The latter is the last village in the area, where people live only between May and September and move down to the village Punn before their houses are buried deep under snow.

At Ghangarea there is a forest rest-house and a Sikh dharamsala amidst *Abies pindrow* Himalayan Silver Fir), *Picea morinda* (Spruce), and *Taxus baccata* (Yew) forest. The dominance of these affects the sunny aspect in the locality. Beneath this forest canopy, *Viburnum* and *Geranium* are conspicuous. The tree-line ends here and the valley opens. From this place there is a bifurcation of the footpath, one branch leading to Lokpal and the other to the Valley of Flowers.

Lokpal (Hemkund), about 14,000 ft. above sea-level, is a holy place where Guru Govind Singh worshipped. It is virtually a paradise for painters and photographers, and is of course a seat of pilgrimage. When I reached Lokpal on 24 September I was stirred with feelings of intense joy and happiness to see such a beautiful lake of crystal clear water. The lake is situated at the base of brilliantly-lit snow peaks. It is significant to note that it does not show aquatic vegetation. *Aconitum violaceum*, *Cassiope fastigiata* and *Saussurea obvallata* (locally called Kamal) are found near the lake. *Potentilla* and *Geum* are amongst the common way-side plants. I returned to Ghangarea on the same day after a pleasant roaming about.

The next morning was cloudy and I followed the track through *Alnus*, *Betula utilis*, and *Cotoneaster bacillaris* trees, leading to the Valley of Flowers along the Bhyundhar stream. On the way to the valley there are two wooden bridges, which swing giddily as one crosses them. The path is a zigzag course, and at some bends one finds the stream covered with snow, and water oozing out through it. The monsoon rain converts the Bhyundhar stream with uncanny speed into a fast flowing river.

I was not fortunate enough to enjoy the outing that day, as the weather was not kind; the clouds gathered and icy winds blew fast accompanied by rain showers. So I was forced to rush back to Ghangarea. As the first rays of the rising sun glowed on the snow-veiled peak, I started for the valley again on 26 September and reached there after enjoying the scenic beauty. The day being pleasant and sunny, I was fully rewarded in visiting the place. The valley was not colourful at that period, yet it showed some little and big patches of alpine flora. The flowers are naturally arranged in different beds. The most spectacular spread was that of *Polygonum vaccinifolium* and *Polygonum affine*. Other herbs, like *Parnassia nubicola*, *Corydalis nana* and three species of *Cyananthus*, seem to spread in the near vicinity, but it is obvious that they extend their range in the valley. I came across a solitary blue poppy, *Meconopsis aculeata*, and many yellow-flowered *Geum elatum* growing here and there in the valley. *Saxifraga diversifolia*, *Polygonum polystachyum*, and *Saussurea* have become common way-side plants. It is interesting to note that several species persist in their classical locality, *Cassiope fastigiata* and *Gaultheria trichophylla* on exposed slopes, *Sedum trullipetalum* on rocks, *Epilobium roseum*, the willow herb, near ditches and close to water or streamline. *Capsella bursa-pastoris* was found to be the neighbour of *Epilobium*. *Potentilla argyrophylla* were closely packed in an open place.

Dipsacus inermis owes part of its charm to the peculiar sequence of development of its flowers, which begin to open as a girdle of blooms half-way up to the conical flower-head. *Allium wallichii* has handsome fragrant purple-pink flowers.

Lastly I may mention here that due to my visit in autumn, I could not see the Valley of Flowers in full bloom. Composits, *Cyananthus*, Saxifragas, and Polygonums were the dominating plants at that time. The valley awakes from winter snow in May-June and the flora is at its best in July-August.

These notes on the Valley of Flowers are based principally on collections made during this visit in 1955. The collection treated herein represents 74 families, 189 genera, 283 species, and 6 varieties. Out of this 18 species and 3 varieties are new additions to Strachey's 'Catalogue of Kumaon and the adjacent portions of Garhwal and Tibet'. The sequence of families followed in this paper is that of Bentham and Hooker. Gymnosperms are placed last.

ACKNOWLEDGEMENTS

I wish to thank my respected teacher Prof. V. Puri for the inspiration and for many suggestions, and Dr. Y. S. Murthy for great help and encouragement. My sincere thanks to Father Santapau for his very valuable suggestions and keen interest, and for kindly going through the manuscript. Thanks are also due to

Mr. U. P. Mookerjee (Calcutta) for lending me the book 'Valley of Flowers', to Mr. M. L. Banerji and my colleague Mr. V. P. Dube for encouragement, and to Mr. M. B. Raizada for the facilities given during my stay at F.R.I., Dehra Dun.

ENUMERATION OF PLANTS

RANUNCULACEAE

Clematis gouriana Roxb. A climber with greenish white flowers in dense axillary panicles on *Berberis* and *Callicarpa arborea*. Srinagar.

Anemone vitifolia Ham. Forming a carpet beneath *Cedrus libani* and *Pinus wallichiana* forest. Joshimath.

**Thalictrum reniforme* Wall. Known as Mamiri in Garhwal, the roots are powdered, and used as Survna. Govindghat.

T. cultratum Wall. (Bl.). Known as Mamira in Garhwal, in achenes and leaves. Pandukeswar.

T. javanicum Blume. A shady herb with white flowers. Joshimath.

**T. minus* L. var. *majus* Jacq. An erect herb in shade of *Rhododendron campanulatum*. Ghangarea.

**Ranunculus diffusus* Royle. A herb with soft hairs on moist shady place. Joshimath.

Aconitum violaceum Jacq. Locally called Atis, not poisonous, abundant at Lokpal.

A. balfourii Stapf. Locally called Bhangwa, deadly poisonous, solitary growing in a fern grove at Valley of Flowers, but abundant on way to Lokpal from Ghangarea.

MENISPERMACEAE

Cissampelos pareira Linn. A climber on *Carissa spinarum* and *Rhus parviflora*. Srinagar.

BERBERIDACEAE

Berberis lycinum Royle. A gregarious shrub with dull yellow flowers. Fruit edible. Joshimath.

B. chitria Lindl. Extraction from the stem and roots is used in medicine, known as Kingora in Garhwal. Joshimath.

PAPAVERACEAE

Meconopsis aculeata Royle. A blue solitary Poppy growing on a precipitous rock at Lokpal, and again a solitary one at Valley of Flowers.

FUMARIACEAE

Corydalis nana Royle. Growing in bunches on moist gradual slope. Valley of Flowers.

C. longipes DC. A weak herb with yellow flowers. Valley of Flowers and on way to Lokpal.

C. cachemiriana Royle. A blue-flowered herb. Profusely growing on slopes and meadows. Valley of Flowers.

CRUCIFERAE

Nasturtium officinale R. Br. The watercress, as it is called, grows profusely in streams and ponds. Srinagar.

Lepidium ruderale Linn. An erect herb near a stream. Srinagar.

Capsella bursa-pastoris (L.) Moench. Abundant near a stream. Valley of Flowers.

VIOLACEAE

Viola serpens Wall. A trailing herb with pink coloured corolla. Joshimath.

V. biflora Linn. Yellow flowered herb growing profusely at Valley of **Flowers.**

**V. distans* Wall. A herb with light pink corolla. Joshimath.

POLYGALACEAE

Polygala crotalarioides Buch.-Ham. A procumbent herb with pinkish violet flowers. Govindghat—Punn.

P. abyssinica R. Br. A long pink racemed herb, in both dry and moist places. **Pipalkoti.**

P. persicariaefolia DC. A herb on dry soil. Srinagar.

P. chinensis Linn. Yellow flowering herb on dry slopes. Srinagar.

**P. erioptera* DC. A herb on dry sandy soil. Srinagar.

**P. tatarinowii* Royle. A small herb with pink flowers in shade. Joshimath.

CARYOPHYLLACEAE

Polycarpaea corymbosa Lamk. Common on dry waste land. In flowers and fruits. Srinagar.

HYPERICACEAE

Hypericum cernuum Roxb. A yellow flowered plant of shady rocky habit. Punn and Pandukeswar.

H. elodeoides Choisy. Comparatively small plant with small yellow flowers, growing at the wood margins or near rocks. Govindghat.

BOMBACACEAE

Salmalia malabarica Sch. et Endl. (=*Bombax malabaricum* DC.). A tree with buttressed stem. Srinagar.

TILIACEAE

Grewia oppositifolia Roxb. A tree known as Bhyunl in Garhwal. The bark of tender branches gives fibre, and the leaves are used as fodder. Srinagar.

LINACEAE

Reinwardtia trigyna Planch. A handsome herb with yellow flowers, growing on slopes at Korchula. Srinagar.

MALPHIGHIACEAE

Hiptage benghalensis (Linn.) Kurz. (=*Hiptage madablota* Gaerten). A large shrub with cream coloured flowers on rocky surfaces at Srinagar.

GERANIACEAE

Geranium collinum M. Bieb. A spreading herb, on moist soil. Joshimath.

G. nepalense Sweet. A prostrate herb with purple flowers. Joshimath.

G. ocellatum Camb. A prostrate herb, on dry slopes. Joshimath.

OXALIDACEAE

**Oxalis latifolia* H.B.K. A shady herb with bulbous roots and pink flowers at Srinagar.

O. corniculata Linn. A widespread herb, in shade. Srinagar.

Biophytum sensitivum DC. A sensitive plant on open waste land. Srinagar.

BALSAMINACEAE

Impatiens sulcata Wall. An erect herb, on moist soil. Valley of Flowers.

I. bicolor Royle. An erect herb in shade. Valley of Flowers.

I. scabrida DC. A pubescent erect herb, in shade. Valley of Flowers.

RUTACEAE

Boenninghausenia albiflora Reichb. A glabrous herb, in the woods, white flowers. Joshimath.

Zanthoxylum alatum Roxb. Known as Timru in Garhwal. The fruit is good for tooth troubles, and is also used as a condiment. Gulabkoti.

Glycosmis pentaphylla Correa. A tree, on dry soil. In seed. Rudrapryag.

Murraya koenigii Spreng. A shrub, on waste land. In flowers. Srinagar.

MELIACEAE

Cedrela toona Roxb. A tree known as Tun. The timber is used in house-making and furniture. Srinagar.

ILICACEAE

Ilex dipyrena Wall. A middle-sized tree. In fruits. Joshimath.

CELASTRACEAE

Celastrus paniculata Willd. A drooping plant, on rocks. In flowers and fruits. Srinagar.

SAPINDACEAE

Aesculus indica Colebr. Known as Pangar tree in Garhwal. The fruit is poisonous. Bhyundhar village.

ANACARDIACEAE

Rhus cotinus Linn. Known as Tunga in Garhwal, a shrub, on waste land. In flowers and fruits. Srinagar.

R. parviflora Roxb. Known as Tunga in Garhwal. The brownish red drupe is edible. In flowers and fruits. Srinagar.

MORINGACEAE

Moringa oleifera Lamk. A tree, in the forest of *Rhus parviflora* and *Carissa spinarum*. In flowers and fruits. Srinagar.

PAPILIONACEAE

Indigofera gerardiana Wall. A gregarious shrub with red flowers. Punn.

I. pulchella Buch.-Ham. A shrub known as Sakina in Garhwal. In leaves and fruits. Pandukeswar.

I. dosua Buch.-Ham. Sub-erect herb with bright red flowers, on open slopes. Punn.

Lespedeza stenocarpa Maxim. An undershrub, on steep rocky slopes, in red flowers. Srinagar.

**Desmodium floribundum* G. Don. A large shrub with pink flowers, on sandy soil. Ghangarea.

D. oxyphyllum DC. A herb with light pink flowers. Pauri.

D. concinnum DC. A tall undershrub with drooping branches. Joshimath.

D. reniforme DC. A weak herb with white flowers, on rich black soil in shade of *Carissa spinarum* and other shrubs. Srinagar.

D. parvifolium DC. A diffuse undershrub, on waste land. In fruits and flowers. Srinagar.

Abrus precatorius Linn. A climber, in dry seeds and leaf. Srinagar.

Atylosia scarabaeoides Benth. A twiner on *Carissa spinarum* and other neighbouring plants. In flowers and fruit. Srinagar.

Flemingia vesita Benth. (=*Moghania vestita* (Grah.) K. & Z.). A creeping herb with dark velvet flowers, in the woods. Joshimath.

Dalbergia sissoo Roxb. A tree fairly distributed on slopes; wood is used in making furniture. Srinagar.

ROSACEAE

Prinsepia utilis Royle. A dark green spinous shrub, in open places. Known as Bhekal in Garhwal. Oil is obtained from the seeds. Punn-Ghangarea village.

Rubus ellipticus Smith. Known as Hinsar in Garhwal. The edible fruit is an aggregation of drupes. Joshimath.

Geum elatum Wall. Yellow erect herb, on moist soil. Lokpal.

Fragaria indica Andr. A spreading herb with yellow flowers, on moist soil. Known as Chota Kaphal in Garhwal. Fruit is edible. Srinagar.

Potentilla fruticosa Linn. An undershrub with yellow flowers, on rock crevices. Valley of Flowers.

P. fulgens Wall. Known as Bazradanti, used in tooth troubles. Valley of Flowers.

P. argyrophylla Wall. Locally known as Kamalya, on meadows and slopes. Valley of Flowers.

P. argyrophylla Wall. var. *atrosanguinea* Lodd. Erect herb with orange petals, in open meadows. Valley of Flowers.

Agrimonia eupatorium Linn. Yellow flowering erect herb, in shade. Valley of Flowers.

Rosa moschata Mill. Known as Kunjo in Garhwal, a large thorny climbing shrub along streams. Bhyundhar and Srinagar.

Stranvaesia glaucescens Lindl. A middle-sized tree with white flowers. In fruits. Joshimath.

Crataegus crenulata Roxb. Flowers white, scented; woody spinescent shrub, on open slopes. The red drupes are edible. Govindghat.

Cotoneaster bacillaris Wall. A small tree, on way to Ghangarea from Bhyundhar village. The branches give convenient walking sticks.

C. microphylla Wall. A prostrate shrub spreading on grassy slopes and rocks in the Valley of Flowers.

SAXIFRAGACEAE

Saxifraga diversifolia Wall. An erect herb, on rich soil. In flowers. Valley of Flowers.

S. filicaulis Wall. A very slender procumbent herb. In flowers. Valley of Flowers.

*S. *moorcroftiana* Wall. An erect herb on sandy soil, in flowers. Valley of Flowers.

S. hirculus Linn. An erect herb, on sandy soil. In flowers. Valley of Flowers.

S. ligulata Wall. A thick short-stemmed herb with showy flowers on poor soil. Joshimath.

Parnassia nubicola Wall. A glabrous herb with long-stalked white flowers. Valley of Flowers.

Deutzia corymbosa R. Brown. A shrub with creamy white flowers, in shade. Ghangarea and Badrinath.

CRASSULACEAE

Sedum trullipetalum Hk.f. & T. It was common on rocks; yellow flowers. Valley of Flowers.

S. ewersii Ledeb. A succulent herb, on rock crevices, in flowers. Mana village near Govindghat.

S. multicaule Wall. A succulent herb with white flowers. Mana village.

DROSERACEAE

Drosera lunata Buch.-Ham. A solitary erect plant with crescent-shaped leaves. In flowers. Valley of Flowers.

MYRTACEAE

Syzygium cumini (Linn.) Skeels. (=*Eugenia jambolana* Lamk.) A tree, in ravines of Balayan, fruit small and edible. Srinagar.

MELASTOMACEAE

Osbeckia stellata Wall. A solitary pink flowering plant, growing in a shady rocky place. Joshimath.

LYTHRACEAE

Woodfordia frutisosa (*Linn.*) Kurtz. (=*W. floribunda* Salisb.) Known as Dhaula in Garhwal; a very handsome red-flowering shrub, growing on rocky surfaces; in full bloom. Srinagar.

ONAGRACEAE

Epilobium royleanum Hausskn. An erect plant, near a stream. Valley of Flowers.

**E. roseum* Schreb. An erect plant, near a stream. Valley of Flowers.

Oenothera rosea Sims. A herb with pink flowers, on moist slopes. Srinagar.

Circaea alpina Linn. A weak erect herb, in woods. Joshimath.

PASSIFLORACEAE

**Passiflora coerulea* Linn. A climber, in flowers and leaves, cultivated. Joshimath.

BEGONIACEAE

Begonia picta Smith. A small herb, on rocks, with showy leaves and flowers. Srinagar.

UMBELLIFERAE

Selinum tenuifolium Wall. An aromatic glabrous herb. Valley of Flowers.

**S. tenuifolium* Wall. var. *filicifolia* Clark. An aromatic glabrous herb, in meadow. Valley of Flowers.

Foeniculum vulgare Gaertn. An erect plant, on waste land. Srinagar.

Daucus carota Linn. A cultivated plant, in Dang locality. Srinagar.

CORNACEAE

Cornus capitata Wall. Known as Bhamora in Garhwal. The red fruit is edible. Joshimath.

CAPRIFOLICEAE

Viburnum cotinifolium Don. A small tree with red drupes, on open slopes. Badrinath.

RUBIACEAE

Oldenlandia corymbosa Linn. An erect herb, on waste land, in flowers. Srinagar.

O. gracilis DC. An erect slender herb, on grassy slopes. Srinagar.

Hamiltonia suaveolens Roxb. Called Padera in Garhwal, gregarious on rock. The leaves and flowers release unpleasant smell when bruised. Srinagar.

Leptodermis lanceolata Wall. It is also called Padera, but it is a small shrub, releasing unpleasant smell when the leaves are rubbed. Srinagar.

Spermacoce stricta Linn. An erect herb, on open slopes, in flowers. Srinagar.

Galium aparine Linn. A trailing herb, in fields. Srinagar.

Galium asperifolium Wall. A common trailing herb. Srinagar.

DIPSACACEAE

Morina longifolia Wall. Locally known as Kandela, thistle-like, erect plant with showy flowers. It was also seen near Badrinath. Valley of Flowers and Ghangarea.

Dipsacus inermis Wall. An erect white-flowered plant, in shady places. Ghangarea.

COMPOSITAE

Solidago virga-aurea Linn. A shrub with yellow flowers. Valley of Flowers.

Aster diplostephioides Benth. A herb with yellow rays, in open meadows. Valley of Flowers.

A. thomsoni Clarke. A herb with violet rays, in open meadows. Valley of Flowers.

A. asperulus Nees. A zigzag-stemmed herb, on sandy soil. Valley of Flowers.

Erigeron linifolius Willd. Abundant, in open dry soil. Srinagar.

Erigeron Sp. A herb with thick rootstock, on damp soil. Valley of Flowers.

Leontopodium alpinum Cass. A woolly herb, on rocks. Srinagar.

Anaphalis nubigena DC. A woolly herb, abundant on slopes. Valley of Flowers.

A. royleana DC. An erect herb, in abundance in sandy soil. Valley of Flowers.

A. triplinervis Clarke. Abundant, on slopes in association with *A. royleana*. Valley of Flowers.

A. araneosa DC. Occasionally seen in meadows. Valley of Flowers.

**Gnaphalium pulvinatum* Del. A woolly herb, on rock crevices. Srinagar.

Gnaphalium luteo-album Linn. A small erect herb with yellow inflorescence, on moist soil. Pandukeswar.

Caesulia axillaris Roxb. An erect herb, on waste dry land. Srinagar.

Inula grandiflora Willd. A hairy shrub, close to a stream. Valley of Flowers.

I. cappa DC. A shrub, on open slopes. Valley of Flowers.

Bidens pilosa Linn. An erect herb, on slopes, in flower. Srinagar.

Tanacetum nubigenum Wall. A strong-scented herb, often offered in Badrinath temple. Valley of Flowers and Badrinath.

T. longifolium Wall. A herb with bright yellow flowers. Valley of Flowers.

Artemisia vulgaris Linn. An aromatic shrub-like weed, on open ground. Srinagar.

**A. vulgaris* Linn. var. *myriantha*. Known as Kunja in Garhwal, a gregarious weed, on sunny slopes. Valley of Flowers.

Senecio nudicaulis Ham. An erect herb with yellow flowers, on slope. Valley of Flowers.

Tridax procumbens Linn. A procumbent herb with flowers, on dry slopes. Srinagar.

Echinops niveus Wall. A thistle-like herb with a globose whitish pink ball, on sunny ground. Srinagar.

Saussurea obvallata Wall. Locally known as Brahm Kamal, a very showy plant, in flower, at Valley of Flowers and Lokpal.

S. taraxicifolia Wall. A small herb, in flower. Valley of Flowers.

S. piptathera Edgew. Occasionally seen on high slopes. Valley of Flowers.

S. albescens Hk.f. & T. An erect herb, in flower. Valley of Flowers.

S. hypoleuca Spreng. A pubescent herb, on a steep slope. Valley of Flowers.

S. denticulata Wall. Abundant, on wayside and in shade. Near Valley of Flowers.

S. gossypiphora Don. Commonly called Yogis King Plant. According to superstition, one person may not collect more than 7 plants, the collection of a large number may result in sudden death. It possesses valuable medicinal properties. Valley of Flowers and Lokpal.

Gerbera lanuginosa Benth. A scape-bearing small herb, common, on open slopes. Joshimath.

Lactuca lessertiana Clarke. An erect plant with drooping violet flowers. Joshimath.

**L. violaefolia* Clarke. An erect plant on rocks. Joshimath.

**L. brunoniana* Clarke. Often seen hanging from rocks. Joshimath.

**Dubyaea hispida* DC. Solitary growing, in open places. Ghangarea.

CAMPANULACEAE

Cyananthus lobatus Wall. An erect herb with showy flowers, in open meadows. Valley of Flowers.

C. integer Wall. Many clumps were seen scattered in the Valley. Flowers showy. Valley of Flowers.

C. linifolius Wall. Spreading widely in the Valley. Flowers blue. Valley of Flowers.

Campanula canescens Wall. An erect herb, on open sunny ground, in flower. Srinagar.

ERICACEAE

Gaultheria trichophylla Royle. Known as Satawari in Garhwal. Fruit is edible. Valley of Flowers.

Cassiope fastigiata D. Don. An erect small herb with crimson flowers, on slopes and meadows. Valley of Flowers.

Pieris ovalifolia D. Don. A small tree, in association with *Rhododendron arboreum*. Flowers white. Joshimath.

Rhododendron campanulatum Don. A small tree, on open ground. In leaf and fruit. Ghangarea.

Rhododendron arboreum Smith. Known as Burans in Garhwal. In scarlet showy flowers. Joshimath.

R. lepidotum Wall. A small shrub with purple flowers, on rocks. Valley of Flowers.

PRIMULACEAE

Primula floribunda Wall. A yellow-flowered herb, on rocks. Valley of Flowers.

Androsace sarmentosa Wall. A herb, on rocky slopes, with showy flowers. Joshimath.

Androsace lanuginosa Wall. A herb, on gradual slopes. Flowers showy. Joshimath.

STYRACACEAE

**Symplocos paniculata* Wall. A middle-sized tree, in flower. Joshimath.

APOCYNACEAE

Carissa spinarum DC. Known as Karonda, at Srinagar, fruit edible. Flowers scented. Srinagar.

Vallaris heynei Spreng. A twining shrub with scented white flowers, on *Euphorbia royleana*. Srinagar.

Ichnocarpus frutescens Br. A twining shrub, on *Rhus parviflora* and *Euphorbia royleana*. Srinagar.

GENTIANACEAE

Gentiana decemfida Ham. var. *aprica* Dcne. A small erect herb, on shady slopes. Srinagar.

G. argentea Royle. A small herb with showy blue flowers forming carpets in open meadows. Valley of Flowers.

Swertia paniculata Wall. A stout herb with white flowers. Srinagar.

S. cuneata Wall. A bluish-black flowering erect herb, on rich soil. Known as Black Chirata. Lokpal.

**S. cordata* Wall. An erect herb, on open dry slope. Srinagar.

BORAGINACEAE

Cynoglossum wallichii G. Don. A dark-blue flowering herb, in open slopes and shade. Valley of Flowers, Ghangarea.

Myosotis sylvatica Hoffm. A decumbent herb, in shady places. Valley of Flowers from Ghangarea.

CONVOLVULACEAE

**Cuscuta capitata* Roxb. A parasite on *Quercus incana;* flowers in a compact umbel. Joshimath.

SOLANACEAE

Solanum nigrum Linn. In fruit and flower, wildly grown. Srinagar.

S. verbascifolium Linn. A middle-sized tree with white flowers, on coarse soil. Srinagar.

S. xanthocarpum Schrad. et Wendl. A spiny plant with violet flowers, on waste land. Srinagar.

**S. seaforthianum* Andr. A shade-loving climber with showy flowers, on *Punica granatum.* Srinagar.

SCROPHULARIACEAE

Lindenbergia indica O. Kuntze. A plant with showy flowers, in moist places. Srinagar.

**L. ruderlis* (Retz.) Voigt. A herb, on moist soil, in flower. Srinagar.

Sopubia trifida Ham. A yellow-flowered herb, on grassy open slopes. Valley of Flowers.

Pedicularis siphonantha Don. An erect herb, on moist soil, occurs in abundance. Valley of Flowers.

P. pectinata Wall. A glabrous herb, in open meadows. Valley of Flowers.

P. carnosa Wall. Very common, in shade and up valley. Valley of Flowers.

OROBANCHACEAE

Aeginetia indica Roxb. A root parasite without leaves, in shade. Flowers deep brownish. Srinagar.

GESNERIACEAE

Rhynchoglossum obliquum Blume. An erect plant with blue flowers, on rock crevices. Pipalkoti.

ACANTHACEAE

Strobilanthes dalhousianus Clarke. A sub-erect shrub, in shade; flowers showy. Near Valley of Flowers.

Barleria cristata Linn. A herb, in dry rocky place. Srinagar.

Adhatoda vasica Nees. An evergreen shrub, known as Kala Bans. It has various medicinal properties. Srinagar.

VERBENACEAE

Lantana indica Roxb. Common on waste lands at Srinagar.

Lippia nodiflora Rich. A creeping herb, near water. Srinagar.

Callicarpa arborea Roxb. A shrub with pink flowers, in shady spots. Srinagar.

Vitex negundo Linn. A common shrub on dry waste soil. Srinagar.

LABIATAE

Plectranthus gerardianus Benth. A small shrub, on moist slopes. Valley of Flowers.

Coleus barbatus Benth. Showy flowers, an erect herb, in rock crevices. Badrinath.

Colebrookea oppositifolia Smith. A common shrub all along the valley, called Binda in Garhwal. Srinagar.

Elsholtzia strobilifera Benth. A small erect herb, on stone. Lokpal.

Mentha sylvestris Linn. A herb, in moist place near a stream, in flower. Srinagar.

Origanum vulgare Linn. An aromatic herb, on open surface. Locally known as Ban tulsi, used as a medicine. Ghangarea.

Thymus serpyllum Linn. A spreading herb with strong aromatic smell, flowers showy. Ghangarea—Valley of Flowers.

Micromeria biflora Benth. A spreading herb with minute leaves, on open slopes. It has some medicinal properties. Srinagar.

Salvia lanata Roxb. A scape-bearing herb, on open slopes. Punn.

Nepeta spicata Benth. Commonly seen on open slopes. Srinagar.

N. graciliflora Benth. A pubescent herb, in moist places. Srinagar.

Scutellaria linearis Benth. An ascending herb, on rock crevices, in flower. Srinagar.

Carniotome versicolor Reichb. An erect herb, near water. Joshimath.

Colquhounia coccinea Wall. A shrub with scarlet flowers, on dry slopes. Gulabkoti and Punn-Bhyundhar.

Stachys melissaefolia Benth. A slender hairy herb, on slopes. Srinagar.

Roylea elegans Wall. An undershrub with grey bark, known as Titpati in Garhwal. Srinagar.

Leucas lanata Benth. An erect herb with white flowers, on open sunny slopes. Srinagar.

L. hyssopifolia Benth. Frequently seen in grassy places. Srinagar.

Teucrium quadrifarium Ham. An undershrub, associated with *Zizyphus* sp. in open space. Srinagar.

Ajuga parviflora Benth. An ascending herb. Srinagar.

A. macrosperma Wall. An erect herb, in grassy land. Srinagar.

PLANTAGINACEAE

Plantago major Linn. A spreading herb, on roadsides and wastelands. Badrinath.

NYCTAGINACEAE

Boerhaavia diffusa Linn. A common weed on rocky ground. Foliage is used as vegetable. Srinagar.

AMARANTHACEAE

Deeringia celosioides Br. A shrub with white flowers, in a moist ravine. Srinagar.

Achyranthes bidentata Blume. A herb, below *Quercus incana* trees. Near Joshimath.

POLYGONACEAE

Polygonum plebejum R. Br. A prostrate herb, on waste dry land. Srinagar.

P. viviparum Linn. Locally called Kukurmakuri, a weak plant growing near a stream at Valley of Flowers.

P. amplexicaule Don. An erect herb, in abundance. Valley of Flowers.

P. affine Don. An erect herb with showy flowers. Valley of Flowers.

P. vaccinifolium Wall. A spreading herb with very showy flowers, on sandy soil and rocks. Valley of Flowers.

P. capitatum Buch.-Ham. A trailing herb, on rocks and slopes, with pink flowers in head. Joshimath.

P. polystachyum Wall. Occasionally seen in meadows. Valley of Flowers.

**P. donii* Meissn. An ascending herb, near water. Joshimath.

Fagopyrum esculentum Moench. Known as Ogal in Garhwal. The leaves give vegetable, and flour from the seeds is called Kotu flour. Bhyundhar.

Oxyria digyna Hill. An erect herb, on moist surface. Valley of Flowers.

Rumex nepalensis Spreng. An erect herb, on sandy soil. Valley of Flowers.

R. hastatus Don. An erect herb, on dry soil. Joshimath.

PIPERACEAE

Peperomia reflexa A. Dietr. Widely spreading on rock layers or on *Quercus incana* bark. Joshimath.

THYMELEACEAE

Daphne cannabina Wall. Known as Satpura in Garhwal; undershrub; paper pulp is made from the bark of the shoot. Near Pandukeswar.

LORANTHACEAE

Taxillus vestitus (Wall) Dans. (=*Loranthus vestitus* Wall). A parasite on *Quercus incana*, bearing rusty-tomentose flowers; the fruits are edible, of chewing gum taste. Joshimath.

EUPHORBIACEAE

Euphorbia hirta Linn. A common weed on dry waste land. Srinagar.

E. royleana Boiss. Locally known as Sulla; a shrub, on dry waste land all along the Valley. Srinagar.

E. pilosa Linn. An erect herb on open ground, in flower. Ghangarea.

E. prolifera Buch.-Ham. Commonly seen. Srinagar.

**E. geniculata* Ortega. An erect plant, on waste land. Srinagar.

Sarcococca pruniformis Lindl. A green undershrub, abundant on wayside from Punn to Bhyundhar village on route to Valley of Flowers.

Andrachne cordifolia Muell. A small shrub, very common on rocky crevices. Joshimath.

Sapium sebiferum Roxb. A solitary shrub near a rivulet. Joshimath.

S. insigne Benth. Known as Khinna in Garhwal, a middle-sized tree with corky bark and thick latex; on dry open slopes high up to the valley. Srinagar.

URTICACEAE

Celtis australis Linn. Known as Kharik in Garhwal; leaves make good fodder. Srinagar.

Cannabis sativa Linn. Bhang plant, an erect herb with green flowers, used variously. Srinagar.

Urtica parviflora Roxb. A solitary plant near water. Valley of Flowers.

**U. dioica* Linn. Very common on waste land and near streams. Srinagar.

Gerardinia heterophylla Dcne. It is known as Bichhu plant, the hairs are stinging. Joshimath.

Pilea umbrosa Wedd. Erect herb, in shady places. Srinagar.

P. scripta Wedd. Common in shade. Srinagar.

Elatostema sessile Forst. Commonly seen, in flowers. Rudrapryag.

Boehmeria platyphylla Don. Called Khagsa in Garhwal. Leaves make good fodder. Srinagar.

Pouzolzia viminea Wedd. A shrub, in moist shady ravine near the G.I. College tank.

P. pentandra Benn. Commonly seen in ravines. Srinagar.
P. hirta Hassk. A decumbent herb, in flower. Srinagar.

Debregeasia hypoleuca Wedd. A pubescent shrub, on slopes. Srinagar.

MYRICACEAE

Myrica nagi Thunb. Locally called Kaphal; the reddish or yellowish brown drupes are edible. The bark is variously used in medicine. Joshimath.

CUPULIFERAE

Betula utilis Don. It is called Bhoj in Garhwal. The bark is used variously. The leaves give a rich fodder. Valley of Flowers.

Quercus incana Roxb. A tree known as Banj, the wood is used as fuel and charcoal. In fruit. Joshimath.

Corylus colurna Linn. Locally known as Kapasi (Himalayan Hazelnut). Tree with fruits and flowers. The fruit is edible. Near Ghangarea.

ORCHIDACEAE

Dendrobium alpestre Royle. A small orchid, on rocks; flowers pink. Joshimath.

Spiranthes australis Lindl. An orchid with white flowers, on moist soil. Srinagar.

Haberaria marginata Collebr. On open slopes, with yellow flowers. Srinagar.

Herminium angustifolium Benth. On shady moist soil, in flower. Joshimath.

Satyrium nepalense Don. On moist soil, with dark pink flowers. Joshimath.

SCITAMINEAE

Roscoea procera Wall. An erect herb with solitary bluish pink flowers. Near Pandukeswar.

DIOSCOREACEAE

Dioscorea sativa Linn. Cultivated for the tubers, which are used as vegetable. Srinagar.

LILIACEAE

Smilax aspera Linn. A climber, on *Carissa spinarum*. Srinagar.

Asparagus filicinus Ham. An unarmed erect shrub; tubers are pickled. Srinagar.

A. adscendens Roxb. A sub-erect shrub, called Jhirna in Garhwal. Juvenile shoots are used as vegetable. Srinagar.

Allium stracheyi Baker. Locally called Dhun pangar, used for flavouring pulses, etc. Valley of Flowers.

A. wallichii Kunth. Known as Chora; flower parts and foliage are used in condiments. On rocks. 3 miles down from Badrinath.

COMMELINACEAE

Aneilema divergens Clarke. A solitary plant with flowers in *Rhododendron campanulatum* shade. 4 miles down from Valley of Flowers.

GRAMINEAE

Crysopogon montanus Trin. Common in waste lands. Srinagar.

Polypogon monspeliensis Desf. Common on dry ground. Srinagar.

Eragrostris tenella Beauv. A spreading herb, on waste land. Srinagar.

E. tenella var. *viscosa* Stapf. Growing on a slope, in flower. Srinagar.

E. amabilis W. & A. Fairly abundant in small tufts. Srinagar.

GYMNOSPERMS

Cupressus torulosa Don. A large tree, on a gradual slope. Joshimath.

Juniperus wallichiana Hook. A moderate-sized tree, on open ground. Ghangarea.

Taxus baccata Linn. Known as Thuner in Garhwal. Locally the powder of the bark is used as tea dust. The fruit is edible. Near Ghangarea.[1]

Pinus wallichiana A. B. Jackson. (=*P. excelsa* Wall). A tree, on slopes. The wood is used variously. Joshimath.

P. roxburghii Sargent. (=*P. longifolia* Roxb.). A tree 'Chir', on rocky slopes. Joshimath.

Cedrus deodara Roxb. 'Deodar' is a tall tree, abundant in eastern slopes. Hanumanchatti.

Picea smithiana Wall. It was found in association with *Taxus baccata.* Ghangarea.

Abies pindrow Spach. A lofty evergreen tree with dark green foliage. Ghangarea.

Note.—The plants marked with an asterisk have not been reported in 'Catalogue of the Plants of Kumaon and the adjacent portions of Garhwal and Tibet' by Richard Strachey, 1852, revised and supplemented by J. F. Duthie in 1906.

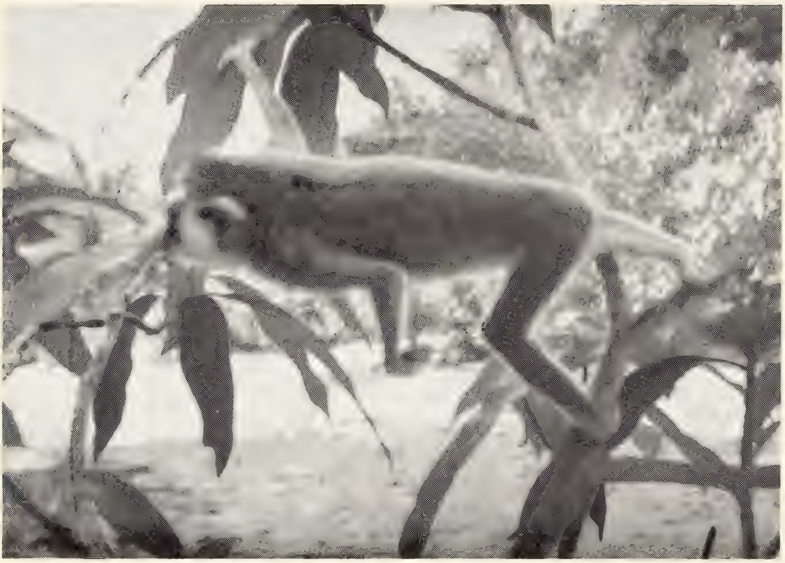
REFERENCES

1. Blatter, E. (1928): The beautiful flowers of Kashmir (1-II).
2. Collett, H. (1902): Flora Simlensis.
3. Hooker, J. D. (1872-97): Flora of British India (I-VII).
4. Smythe, F. S. (1939): Valley of Flowers.
5. Strachey, R. (1906): Catalogue of the plants of Kumaon and adjacent portions of Garhwal and Tibet.

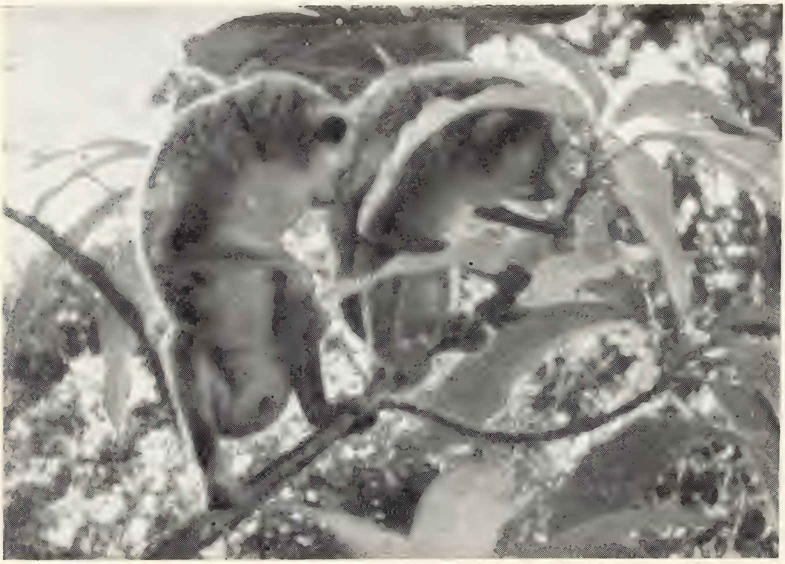
---

[1] All parts of the Yew tree, except the aril round the fruit, are known to be deadly poisonous. This local use of the bark is rather striking. The aril is edible, the rest of the fruit is not.—EDS.

LORIS TARDIGRADUS



Position in climbing



Position at rest

Photos : Mrs. Swarna Subramonian

SOME OBSERVATIONS ON THE HABITS OF THE SLENDER LORIS, *LORIS TARDIGRADUS* (LINNAEUS)

BY

(MRS.) SWARNA SUBRAMONIAM, M.SC.

(*With five plates*)

The anatomical aspects of *Loris tardigradus* have been subjected to an extended study by a series of workers. As one of the two living representatives of Lorisiformes of the Lemuroidea and a typical example of a tailless primate possessing such distinctive structural adaptations providing numerous striking morphological characters similar to the Anthropoidae and Hominidae and at the same time retaining some of the features of the primitive Mammalia, *Loris tardigradus* deserves a closer study regarding its habits.

Confined to the forest-clad misty ravines of the High Range in Travancore, Nilgiri Hills, and south-west Ceylon, its nocturnal, retiring, and arboreal habits, and its innocuousness to other fauna sharing the same environment make it difficult to observe in its natural habitat. The following is the result of an attempt to study the habits of eight specimens kept in captivity, with as much simulation as possible of the natural arboreal environment. They were reared in spacious deal-wood boxes with wire-netting fronts. Every morning, after cleaning the cages, fresh branches with foliage of jak, anjili, portia, mango, punna, or cashewnut trees were arranged inside the cages to provide natural arboreal surroundings. They were fed early morning and late in the evening. A shallow can filled with fresh water was provided every morning in each cage.

FOOD

A wide range of different food materials, both vegetable and animal, was given to the animal to study its likes, dislikes and preferences. Although omnivorous, it has been found to be predominantly insectivorous. The following were the food materials experimented with:

Vegetable Food: plantain, jak, mango, papaya, and rose-apple fruits, dates, currants; fried potato, plantain, and jak chips.

Animal Food: grasshoppers, mantis, crickets, cockroaches, termites, butterflies, moths, caterpillars, carabids, scarabids, stink bugs, dragon flies, damsel flies, lacewings, house fly, wasps, carpenter bees, rats, frogs, caridina, prawns, fish, earthworms, milk, and eggs.

Of the vegetable foods, plantain fruit was the only item which the animal ate, and that too only when the fruit was in an over-ripe condition. All the other items were summarily rejected.

Of the insects listed above every one was relished with the exception of stink bugs, butterflies, moths, hairy caterpillars, ant-lions, wasps, and carpenter bees, which were rejected. It was consistently observed that the loris ate only live insects. When dead insects were offered they were thrown away without hesitation.

Certain noteworthy characteristics were observed in the method of killing the insects and eating them. Whether the insect lay on the floor of the cage, or was placed on the branches, or was proffered in the cage at the end of a pair of forceps, the loris never picked it with its mouth. The insect is first of all caught by both its hands if the victim is a big one, or by the left hand if the insect is a small one—always and consistently by the left hand. Only on one occasion the loris was found using the right hand to catch an insect, and at that time the left hand was gripping a support. When an insect was securely caught in the hand, the anterior part of the victim was taken right into the mouth and the head was crushed between the molars, probably to put a stop to its struggle. Invariably on all occasions, the head of the insect was first of all bitten off and eaten. Then the entire body, wings, and the appendages were devoured. Two exceptions were noticed in its usual habit of consuming the entire insect. In the case of cockroaches, after munching the abdomen, which is the last portion consumed, the loris spits out the black alimentary canal. In another instance, when a Rhinoceros beetle (*Oryctes rhinoceros*) about 2″ long was the victim, the loris rejected the legs, the elytra, and the wings. It was noticed that the loris munched that part of the wings where they were attached to the thorax and threw away the membranous part. The legs and elytra were too chitinous and hard for the loris to chew. Curiously enough, this beetle although much bigger than a cockroach did not suffer the ignoble fate of the latter of having its alimentary canal jettisoned. With the exception of the legs, elytra, and wings the entire beetle was consumed. The intestines of the cockroach alone are found to be distasteful to the loris. The causes for this rejection are being investigated.

On one occasion a young rat (about three days old) happened to fall down from the ceiling of the house. The creature was obviously stunned by the fall and lay still, breathing and living. It was tendered into a cage containing four lorises. They attacked it with avidity, each one struggling to get a major portion, and within five minutes the entire rat was consumed. With a view to see whether the lorises are able to subdue an adult rat, one (about 3″ long) was caught in a trap next day and left in the cage. An hour later it was found that the posterior half (abdomen, legs, and tail) of the rat was left unconsumed.

The lorises ate live fish. The fish offered was *Aplocheilus* caught from the lake near-by living and struggling when introduced into the cage. It is strange that they relished the fish, a food material which obviously they are not accustomed to. Being arboreal animals catching such prey as they find on the trees they could not have come across any fish before.

Experiments with frogs and earthworms indicated that the lorises do not relish these creatures.

Liquid and semi-solid foods like milk and yolk of eggs were lapped up with the tongue. It drinks water sparingly from the can kept inside the cage. Water is lapped up with the tongue and, unlike the

Anthropoids, the loris does not drink water by suction through pouted lips.

To find out the maximum quantity of food it could consume at a time, each loris was fed with cockroaches on different dates. The average maximum was seen to be seven cockroaches.

While feeding, it was strange to notice that the first bite the loris gives to the head of the victim was by taking the anterior part of the insect far into the mouth between the molars, and not by the incisors. In spite of the fact that it has sharp incisors, the animal did by-pass them and took the insects on all occasions to the molars. Even when a piece of plantain fruit was given, the piece was caught by the hand and then pushed far into the mouth. The act of deliberately pushing the pieces in could be unmistakably seen. Is it because the incisors are not able to function, or are their bites ineffective? The following experiment was conducted to study them.

As usual, pieces of the plantain fruit were introduced into the cage stuck at the end of a slender wooden splinter. I wanted so to manage it that the loris bit the piece without taking hold of it in the hand. The branches, foliage, and perches kept inside the cage were removed. The loris had only a narrow platform, jutting out from the posterior side of the cage, to sit on. The wire-netting front was about nine inches from the platform. I introduced the fruit piece at the end of the wooden splinter high up through the wire-netting. The loris had to stand on its legs to reach it. The grip its legs maintained at the edge of the platform was not convenient to slant its body forward over nine inches. So it placed both its hands on the wire-netting for support. As it could not remove either of the hands it extended its neck and took the piece of fruit between its jaws. I noticed that the open mouth was being pushed forward, so that the fruit piece got between the molars on the right side before it closed its jaws and removed the piece from the splinter. This performance was satisfactory for the purpose of the investigation. When the next piece of fruit was about to be caught between the molars, I withdrew the splinter so that the bite fell between the incisors. The animal immediately opened its mouth again to get the piece further in and at this time I took away the splinter with the fruit piece for examination. The fruit piece was not severed and, as it was a soft over-ripe fruit, the impression of the incisors was not distinct; at any rate, the result of its bite on a soft ripe fruit gave sufficient indication that the bite of the incisors will be totally ineffective on the chitinous shell of an insect. To be abundantly cautious before arriving at such a conclusion, I wanted to examine the impression made by the incisors. I repeated the experiment with a piece of ripe but firm (not over-ripe) plantain fruit. But unfortunately the loris would not touch it.

ADAPTABILITY OF THE LIMBS

The shoulder joint of the loris is endowed with almost universal movements of flexion, extension, abduction, adduction, and circumduction comparable to those of Anthropoidae and Hominidae, and more specialised than those of a generalised type of mammal. The hip joint permits the hind limb all the above mentioned movements to a greater range, much more than the Anthropoidae and Hominidae are capable of. There are few parts in the body which the toe cannot be made to explore, and the leg has its maximum mobility. It is remarkable to note the following wide range of mobility of the leg. In abduction, the thigh is capable of being raised outwards and upwards, so that the toes can touch the opposite shoulder across the back. In circumduction, by a combination of all movements it is capable of, the lower limb can move round a large circle, larger than could be possible for any of the Anthropoidae or Hominidae. The curious gait with which the animal moves on the ground and on the branches of trees, and the astonishing postures it is capable of assuming are evidently the result of the extraordinary powers of circumduction of its hind limbs. The legs although relatively slender seem to have been provided with powerful muscles. While grasping a vertical branch with the legs, the animal is seen capable of stretching its legs and body to their full length in almost a horizontal plane in order to get a grip on an adjoining branch. The animal is also able to maintain this posture for a long time.

The hand has a remarkable resemblance to that of man (fig. 1). The palm (fig. 2) is broader and flatter than the wrist and continuous with the front of the forearm, but its surface is raised from that of the forearm by the thenar and hypothenar prominences at the bases of the fingers. The opposable thumb is widely separated from the other digits. All the five digits have flattened nails, the distal ends of which come within 2 mm. of the extremities. The extraordinary mobility of the thumb distinguishes it from that of the Anthropoids. The thumb is well developed and its axis is directed downwards and outwards. The opposability of the thumb is influenced by its rotation, and an attempt was made to express this rotation by means of the angle between the transverse axis of the thumb and the transverse axis of the other digits. These axial lines were determined by a modification of the method adopted by Schultz (1) for a similar measurement in the gorilla. The fingers II to V were held straight and touching each other, and the thumb was abducted as much as possible. The axial lines were the median line passing through the third finger and that passing through the thumb. The angle between these lines was measured with a transparent protractor. The mean of the readings taken gave an angle of 120 degrees.

Schultz (1) records: 'Among the Simian primates the thumb is least rotated in Platyrrhines and most in the great apes. It is surprising to find that the thumb of man is, on an average, less rotated than are the thumbs of the Old World monkeys and apes. In the Chimpanzee the thumb rotation has reached the extreme, the relevant angle averaging less than 90 degrees.'

From the measurements taken of eight specimens under observation the thumb measured 12 mm.

The second digit is the shortest of the five and measured only 10 mm., giving a rudimentary appearance. Its nail is very small.

The third digit is 15 mm. long, the fourth digit, the longest in the hand, is 17 mm. long, and the fifth digit is 14 mm. long. The relative elongation of the fourth digit in the hand is a characteristic of the Loris, when in both Anthropoids and Hominids the third finger is the longest. Morton (2) has pointed out that such a disproportion in the digital formula may be related to the fact that, when the hand grasps a branch of a tree, a more secure hold is obtained if the palm is placed obliquely across it with the thumb opposed to and meeting the other digits round the branch and in this way increasing the span of the grasping hand.

When the hand is not employed either in catching hold of a branch or in walking, it is held up with the fingers clenched into a fist (fig. 7). The fingers close over the palm with the thumb below the second and third digits. It is also observed that, when the fingers are opened out or when around a branch in the act of gripping, the second digit which has a rudimentary appearance never straightens out, the distal phalange is always held slightly flexed inward (fig. 3).

The hind limb has a well developed hallux, very widely separated from the second digit, so widely abducted that it extends backwards. The hallux has all the mobility of the thumb and is opposable to the other digits of the foot but, however, not to such an extent as the pollex. The angle of abduction of the big toe is also 120 degrees. The big toe is 14 mm. long and has a small flattened nail.

The second toe is 10 mm. in length with a small pointed claw 5 mm. long. While all the other toes have small flattened nails, this second toe alone has a specialised sharp claw. Le Gros Clark (3) has pointed out its functional importance for grasping. Claws will undoubtedly increase the grip of the limb. But careful and continued observation does not confirm the statement that in *Loris tardigradus* the claw on the second toe helps the animal in grasping. It is found that the claw has very little part to play when the limb grasps a branch. It is seen that, when the hallux and the toes in opposite directions go round a branch, the second toe is so disposed that the claw lies over the third toe (fig. 8), its point does not touch the object within the grip, and unless the sharp point of the claw comes in contact with the branch it cannot serve any purpose in actually increasing the security of the grip. This peculiar disposition of the second toe cannot be considered as an abnormality in one loris since it has been observed in all the specimens examined.

Le Gros Clark (3) has suggested that this claw may be used by the animal for toilet purposes. Actually it was seen that the animal often used the second toe to scratch the body, and in doing so, since the toe is the shortest, the other toes close over the plantar surface so that the clawed toe stands out for the efficient use of the sharp appendage (fig. 12). In view of the fact that all the nails on the fingers and toes appear to be rudimentary and do not even extend to the tips of the digits, the animal uses the claws for scratching its body. Under the circumstances the sharp claws in the second toes are the only available appurtenances capable of penetrating the thick coating of fur for effective scratching.

The third toe is 13 mm. in length. The fourth toe, 15 mm. long, is the longest of the toes, and like the fourth finger shows a specialised functional adaptation for grasping. The fifth toe is 12 mm. long.

When the foot is raised from the ground or away from a branch the toes close in, but not to such an extent as the fingers of the hand.

The hallux and the toes bend towards each other leaving a gap between them.

The plantar pads are more prominent than those in the hand, more individual and often separated by grooves instead of lines. The thenar eminence is large and occupies almost half of the plantar surface, separated from the distal half by a deep groove starting from the centre of the inter-digital lobe between the hallux and the second toe and going up the hypothenar pad. On either side of the groove, the interdigital lobe thickens into two protruding processes. The faint lines and ridges, straight, concentric, and in loops, are seen on the plantar pads, having the same functional significance as those of the hand.

Morton (2) suggests that in Primates of more thoroughly arboreal types the foot is used to maintain to a greater or lesser degree a clinging or perching grasp of the branches, and that this has led to a specialisation and the wide abduction of the hallux, which can be opposed to the outer digits. The same holds good for the hands as well in the *Loris tardigradus*. All the postures and movements of the specimens I was able to observe made use of the predominant faculty of the limbs to have a firm grip. It was found difficult to dislodge the animal when once it had gained a grip on a branch.

The most characteristic pose is that it takes when at rest or sleeping. It rests or sleeps rolled up like a ball with the head and hands between the thighs. The legs take a firm grip round a branch with the lower portion of the torso resting between a fork formed of two branches or even on a horizontal limb of the tree. Sometimes the hands also catch the same branch which afforded a grip for the legs or another branch close by (figs. 15-18). The constant habit, as observed later, of the loris to frequent and remain on the outermost slender branches or twigs, surrounded by foliage, has presented the animal in the sleeping pose with their haunches not resting on bare naked branches. Before it settled down, it was seen pulling down one of the adjoining leaves and taking a seat with the leaf immediately below the haunches to relieve the discomfort of the hard bare surface of the branch. This possibly explains why *Loris tardigradus* has no ischial callosities often noticed in such arboreal animals as monkeys. Several variants of this posture have been observed and in all these the variations occur only in the disposition of the limbs in accordance with the availability of convenient branches nearby.

When, frightened, as for instance by bringing a dog in front of the cage, the loris stands erect on its legs with the arms drooping on either side of the chest, the hands clenched, and elbows held up at the level of the sternum (fig. 19). It remains steady and without the slightest movement in this posture stares continuously at the object it is afraid of or towards the direction from where a frightening sound is heard. But the attitude was different when a small pup was presented to it in front of the cage. It then stood up on its legs with clenched fists and half opened mouth, fixed a savage glare on the pup, and made repeated short starts as if about to spring forward, uttering at the same time audible guttural sounds.

The movements of the animal are slow and deliberate, and dependent on the grip of the limbs. It relies more on the grip of the

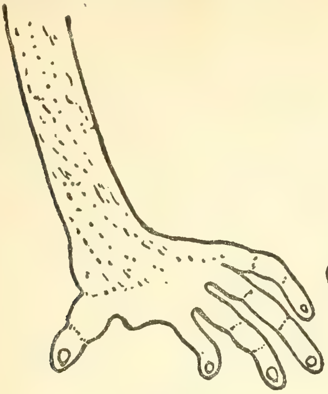


Fig. 1

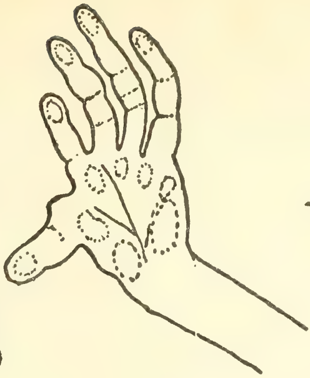


Fig. 2

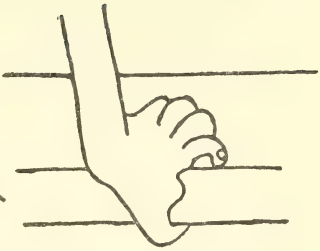


Fig. 3

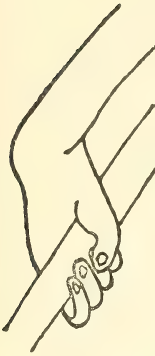


Fig. 4

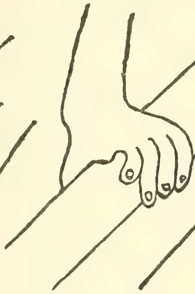


Fig. 5

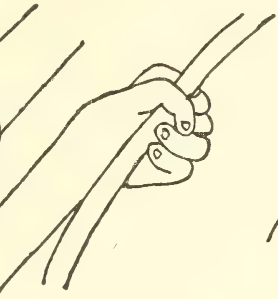


Fig. 6

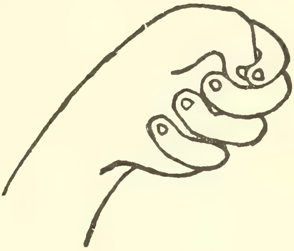


Fig. 7

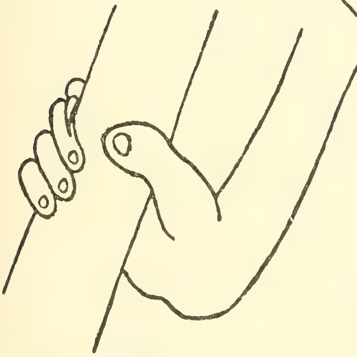


Fig. 8

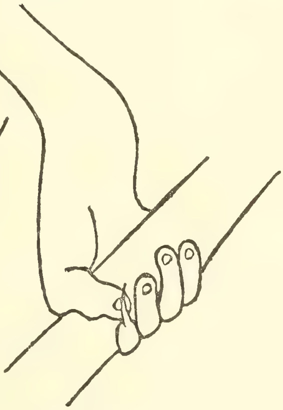


Fig. 9

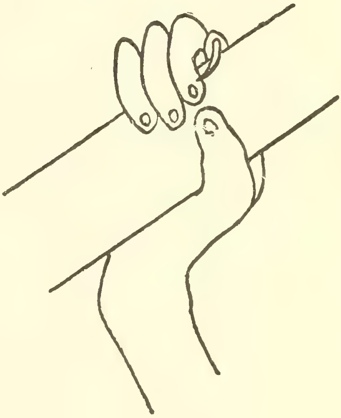


Fig. 10

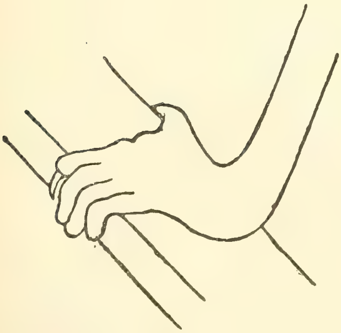


Fig. 11

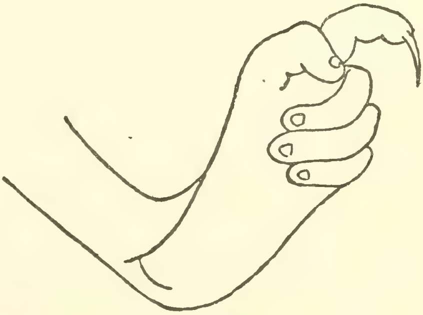


Fig. 12

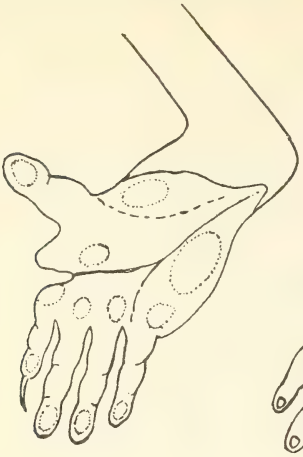


Fig. 13

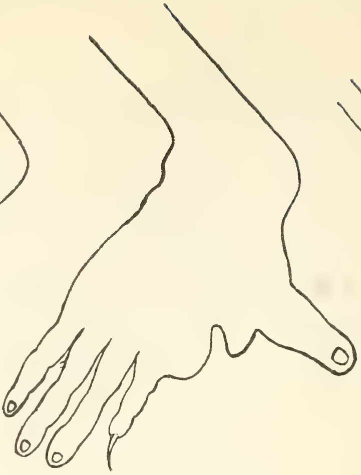


Fig. 14

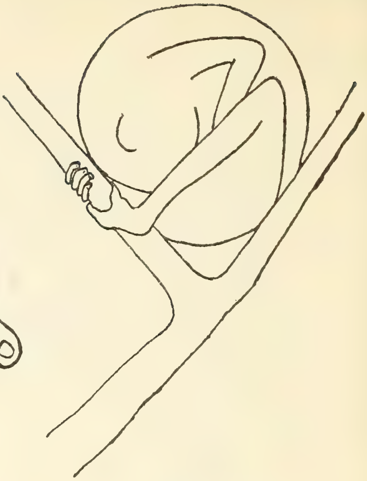


Fig. 15

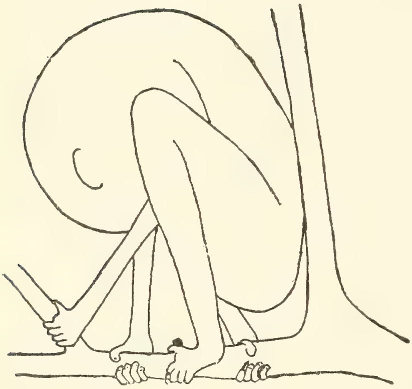


Fig. 16

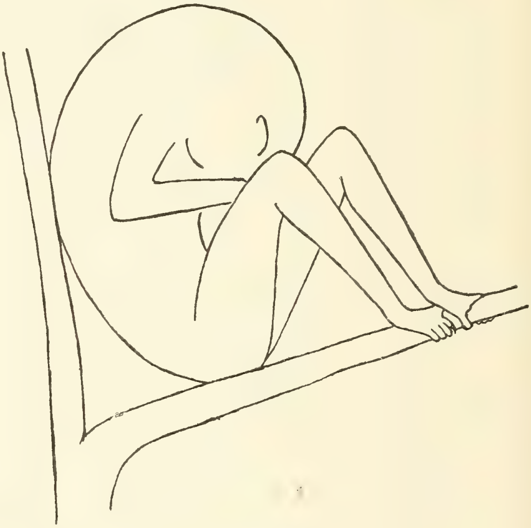


Fig. 17

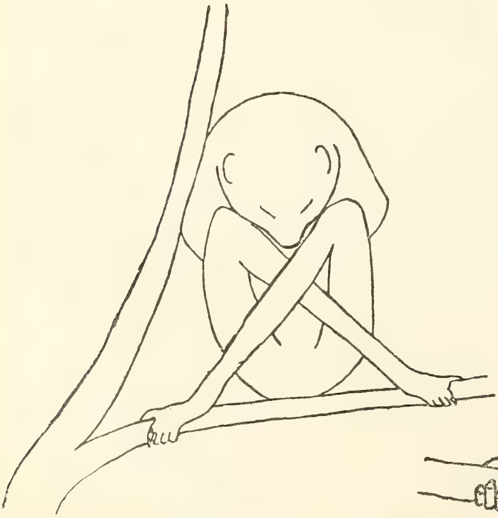


Fig. 18

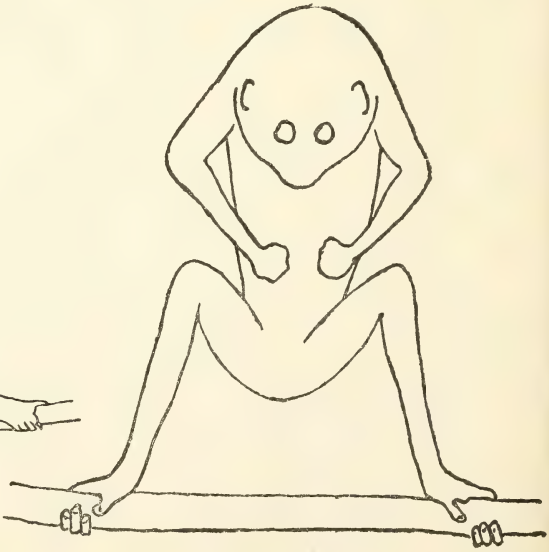


Fig. 19

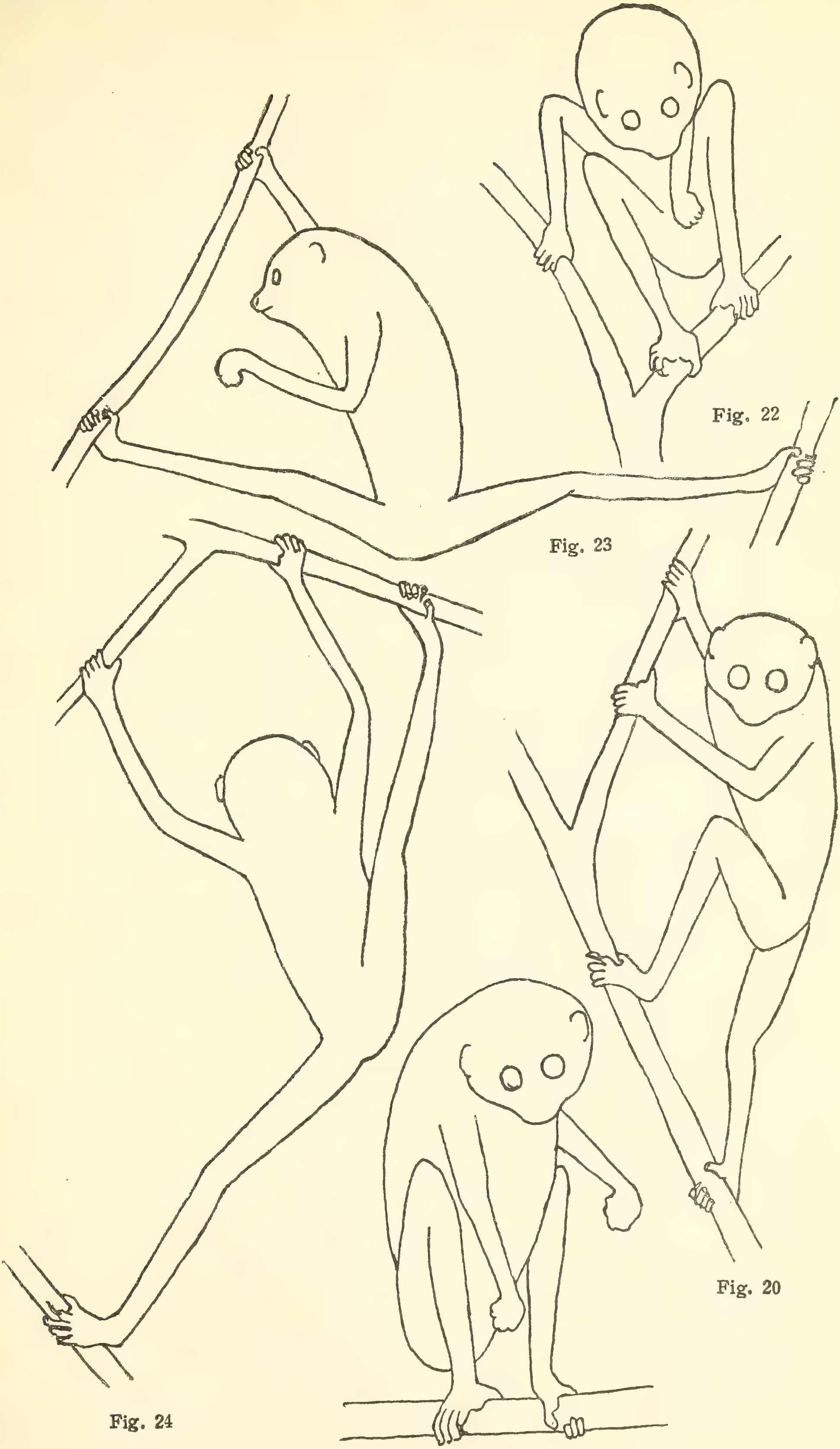


Fig. 22

Fig. 23

Fig. 20

Fig. 24

Fig. 21

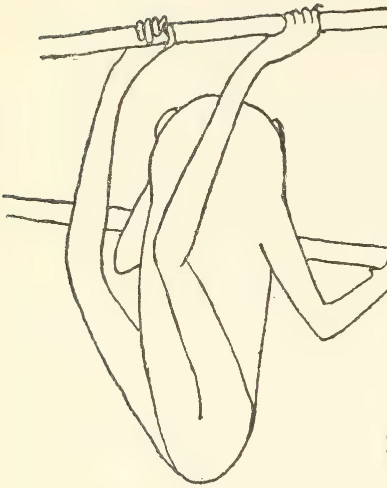


Fig. 25

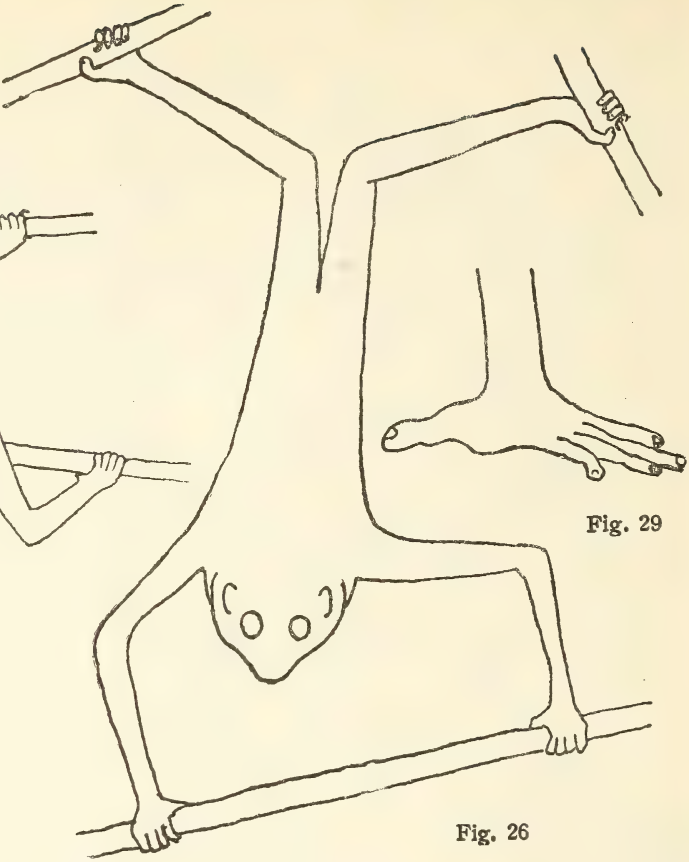


Fig. 26

Fig. 29

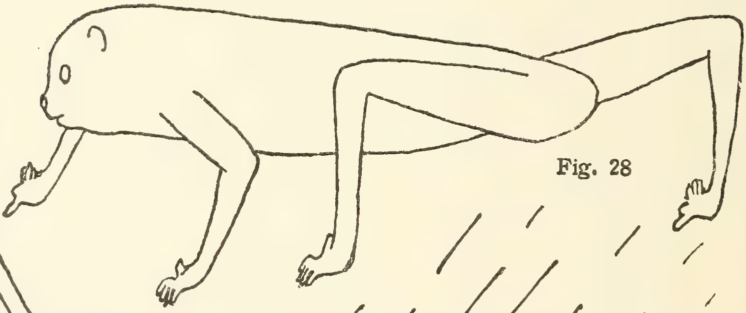


Fig. 28

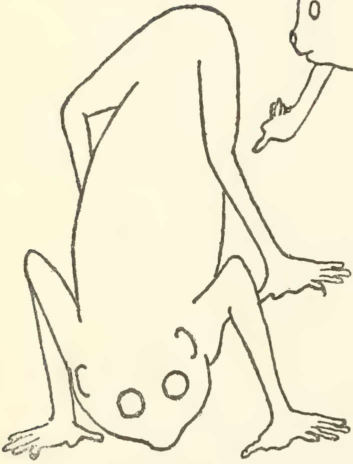


Fig. 27

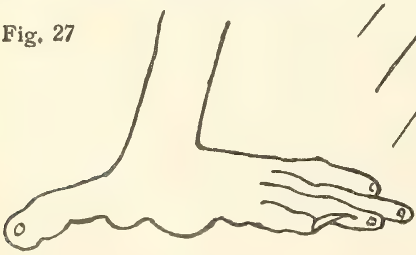


Fig. 30

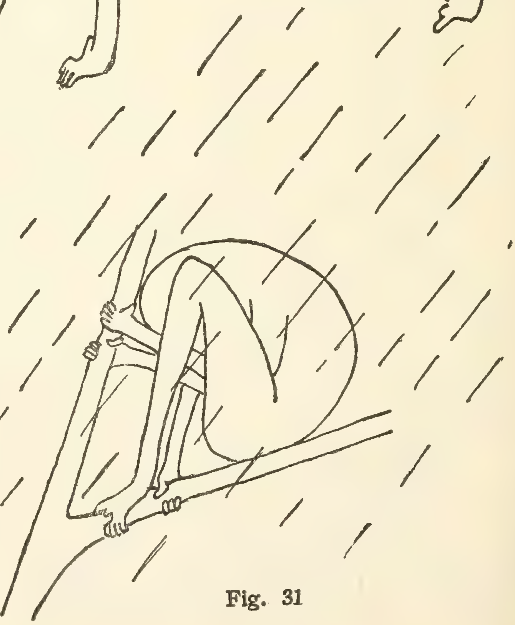


Fig. 31

hindlimbs than on that of the forelimbs, and I have found that the former are far more tenacious than the latter. While moving forward the limbs advance in the following order: right hand, left leg, left hand, right leg, in the same manner as an experienced climber goes up a coco-nut tree in Travancore. Its deliberately slow and careful movement can be seen to be the result of its hesitation to move forward its hand unless and until the advancing leg has secured a firm grip. This instinctive reliance on the grip necessitates its circumspection to select a twig sufficiently slender to get a firm grip on. Since a twig of more than half an inch in diameter does not allow its toes to completely encircle it, the animal looks round and prefers such supports in its surroundings that could enable its legs to get a firm grip. It has also been observed that, if it suspects a twig over which its leg has been placed to be a dry one or likely to break off, the leg is immediately removed and seeks after another suitable support. While climbing up, the forelimb serves to steady the position, and it is the hindlimb that pulls up the whole body. (Plate, photo I.) While climbing down, head downwards, the hindleg slowly lets down the body and, until the other leg secures a firm grip in a forward position, the rear leg is not removed from the branch. It was interesting to notice that the hindlimbs are capable of rotating a full wide circle about the hip joint, permitting their use at all imaginable angles (figs. 23-26). The forelimbs seem to have certain limitations to such a wide range of movements.

Its movement on a flat surface is also slow, deliberate, and seems to be handicapped by the peculiar position of the digitals of the hand and the leg (figs. 27-28). Being specially adapted for grasping, the pollex and hallux are placed opposite to the other digits and widely separated from the respective second digits. While walking, the thumb of the hand makes a very wide obtuse angle with the other fingers, and the base of the angle is anterior to the fore-arm (fig. 29). The same is the case with the leg (fig. 30). With such a disposition of fingers and toes, a forward movement as a result of the digitals pushing back the ground under it is difficult or not effected in a manner that could be done when the digitals are extended to the front as in Anthropoidae and Homindae. Left on the ground, the loris walks with an uneasy gait but faster than it can climb up the branch of a tree. It is evident that the limbs are adapted more for prehension than for locomotion on the ground.

To observe the animal more closely in its arboreal environment, I selected at first a short spreading mango sapling about four feet high, and left the lorises free near the foot of the stem which was about an inch in diameter. They immediately proceeded towards the small trunk, climbed it, and quickly passed on to the tiny branches. Suspecting that this tendency to go up to the extremities of the branches might be due to the lack of a larger surface area in which to move, I transferred the animals to a small spreading cashew-nut tree about ten feet high. I still noticed the same tendency of going up and up to the end of the tiny branches; here they settled down to double up ventrally and go to sleep. It was ten in the morning, and I could not see any further movements on the tree as they slept in the day-time. Early next morning, just after 5-30 a.m., I repeated the previous day's experiment by letting loose the lorises on the same cashew-nut tree. They behaved as they did before, and went out to the extremities of the branches. One of them walked along a thick branch going sideways, avoiding the one standing vertically. It did not attempt to climb up this branch which was more than an inch in diameter. It continued along the horizontal branch till it came to another vertical offshoot about half an inch in diameter, which it climbed. I was led to suspect that the animal was either unable or felt it difficult to climb up any limb of the tree which was too thick for its feet to grip, and that was perhaps why it always went out sideways in search of a slenderer branch. To test this I took out the lorises from the tree and let them loose at the foot of another cashew-nut tree, whose trunk was about four inches in diameter and with no branches within three feet of the ground. The trunk was smooth without any notches or cracks. The lorises attempted to climb it but they failed. They could not get a grip on the smooth surface of such a thick stem, even with the help of the sharp claws on the second digits of the hands and feet.

I transferred the animals to the foot of a large portia tree, whose bark was cracked into deep crevices and rough projections. The lorises succeeded with evident difficulty in grasping the broken bark and climbed up the tree. This shows that the animals have to rely entirely on the grip of their feet and hands for arboreal locomotion.

In all my observations of its movements on the trees I did not notice a single instance when it could jump or swing out from one branch to another. I have noticed the animal hanging from a branch by its feet in order to reach another support below, but have never seen its hanging by its forelimbs. To test its capacity to jump from one branch to another I conducted the following experiment.

I let loose a loris on a slender branch of a solitary cashew-nut tree. It moved slowly along and, when it reached the extremity of the branch, I bent down the branch so that the twigs and leaves were about two feet away from the adjoining twigs. The loris moved about on the branch in order to come to a position close enough to be able to reach out to one of the twigs farther away. Finding none available, it stood on its legs and tried to reach up. Failing again, it settled down and sat quiet. If it could jump it would have certainly done so.

It was rather difficult to observe their movements at night. A two hour watch by shifts was arranged one night to observe them. The animals were awake throughout the night, and were constantly moving about inside the cage showing unmistakable signs of impatience.

A marked difference was observed in the way the loris grasps a horizontal support by its feet, characteristically different from what a member of the Anthropoidae does. An anthropoid leg grasps a horizontal branch in front with the plantar surface away from it. The loris is seen to grasp it with the plantar surface towards it. In the case of a vertical or nearly vertical branch there seems to be no difference in the method of the grasp in the loris and the anthropoid.

At the beginning of the study under report, the lorises were kept for a few days in spacious cages with wire-netting fronts with perches inside them. A narrow wooden platform was also provided at one end of the cage. The animals seldom came to the floor of the cage, but always remained on the platform or preferably on the perches. One morning, I introduced into the cage thick branches with copious foliage to simulate an arboreal environment. I could notice the marked enthusiasm and pleasure of the animals at the close proximity of the green moist leaves. They climbed over the twigs and, having settled in a place, began to lick up the tiny dew drops found on the leaves. Perhaps this is how they quench their thirst in nature for in the High Range, where the slender lorises are found, there are few streams and these at long distances. A journey to a stream would necessitate movement on the ground at times, which these animals avoid. Their slow, unsure, wavering progress over unfamiliar ground on the way to the stream would, moreover, expose the defenceless creatures to danger from predacious animals. From all this I am led to speculate that the loris quenches its thirst by licking up the dew drops on the leaves of the trees. In the dense forests of the humid misty ravines of the High Range dew drops are always present on the leaves in the mornings.

Their habitat in the High Range of Travancore is subjected to heavy rainfall during the monsoon. To find out how they behave when it rains, I projected a light shower of water over them to simulate the rain. They did not run about to take shelter, but simply doubled up ventrally (fig. 31). In this position they protected their open ears and by bringing up the knees over the ears on both sides, prevented water from entering them. The thick coating of fur kept the water particles on the surface and it was found impossible to drench the animal through. When the spraying stopped, they licked off the water from all over the body. Each individual assisted its neighbour in thus drying and cleaning the fur. After licking off the water, the lorises preened their coats carefully with the help of the sublingua and probably the incisors as well. The action of the sublingua was clearly seen, but that of the incisors was not so definite, although during the cleaning the incisors constantly came in contact with the fur.

Sociability and Docility

For the first few days the lorises were kept in separate cages to prevent them from fighting with each other. After four days two male lorises were put together in one cage. They did not fight. Producing a low screeching sound, they approached each other and behaved in a friendly way, showing that they liked to be together. Each one in turn preened and cleaned the other's body, beginning with the face. The cleaning was done as follows: the hands caught hold of the skin wide apart and with the sublingua and incisors the fur was combed and cleaned. After this demonstration of friendliness they huddled together in a corner on the narrow platform.

From the next day four lorises were placed in the same cage for observation. They were always friendly except when food was introduced into the cage. There was then a momentary fight for the food, one snatching away the material from the other. But when the aggressor moved away with what he got, the other did not chase him. In daytime all the four lorises could be seen huddled together and sleeping. This tranquillity was disturbed at night when at frequent intervals a variety of sounds were heard emanating from the cage. When bright light was suddenly brought near the cage for observation, the animals became quiet. But by slowly bringing a flickering diffused light near the cage, their activities could be observed. The youngest loris (trunk length 14 cm.) was sitting on a branch and another inmate was trying to pass him in order to mount the platform. The young one resented this giving out a low growl. But when the other persisted in his right of way, he gave a screech and caught hold of both the ears of the intruder with his hands. Once the ears were thus caught the victim became helpless and gave out a characteristic cry of helplessness. Probably such a grip on both the ears prevented the animal from moving his head even if he wanted to retaliate. In another instance, where a female and two males were kept in a cage, there was regular pandemonium at night. The female loris fought off any male coming near her, while the males fought constantly with each other. But they were all quiet and friendly during the daytime.

The general procedure of the fights was the same, the attacked trying to ward off the bites of the attacker by holding on to his ears. Since the fingers have blunt, flattened nails, which do not project beyond the extremities of the digits, the holding of the ears does not result in any damage beyond the removal of a few hairs of the fur. In these fights, the limbs take no part since they are fully occupied in maintaining the position of the animals on the branches.

When several lorises are left free on a tree, they 'follow the leader' and crowd near each other on one branch. No instance was observed when they tried to distribute themselves on the tree.

This shy, retiring animal does not show any vicious aggressiveness towards humans. Conscious of its limited powers of defence, it always attempts to get away from any person coming near and takes the first opportunity to climb up a tree or other support. My first attempt to pat the animal on its back drove a shiver down my spine when, as a warning not to take liberties with it, my thumb received a sharp bite. On examination of the bleeding spot I found that a canine had punctured a deep wound like that of a narrow sharp chisel. Later, such bites were frequent when the animals were taken out of or put into the cages. It is strange to find that on all occasions only one canine succeeded in piercing the finger, possibly because only the lower canines are sharp and the upper canines blunt. They are under investigation.

After four months of handling and feeding the lorises, I found them not so afraid of me as they were at first. The bites became infrequent and the animals allowed me to pass my hand over their backs. They became so docile that during feeding time they would take pieces of food straight from my hand. It may be possible to tame the loris completely if captured young.

Sounds Produced

The following sounds produced by the loris were identified:

1. Growl: When I attempted to catch the animal by running the thumb and forefinger of my hand from behind and over the chin to prevent its biting, it gave a growl, somewhat like *gr-gr-gr-gr*, a low-pitched angry sound. The same growl is produced when one loris does not like the approach or the close proximity of another.

2. Screeching: At night a long continued screeching sound, not unlike that of the chirping of crickets, is heard.

3. Whistle: Sometimes, when two lorises who were kept for a long time in separate cages are put in one, they come together emitting a low, short whistle. Probably this indicates satisfaction.

4. Distress Sound: One day, when I introduced into the cage a fairly large mantis, two lorises fought for the insect. One of them subdued the other by the usual hold on the pinnae of the ears. At that time the vanquished put forth a long distress sound like *kree-kree-kree* in quick succession.

5. Warning Sound: Whenever a dog was presented in front of the cage, the loris produced a warning sound like *krichit-krichit-krichit-krichit* in quick succession, and stood upon its hind legs. The other lorises in the same cage, on hearing the warning, took a similar defensive position on their legs.

6. S.O.S.: In the morning, the lorises are usually let out of the cage for exercise. They are allowed to climb up and roam about the trellis of the veranda. After half an hour they are coaxed back into the cage. But often one or two refuse to be led to captivity. To avoid its bites, a thick hand-towel is put over its head and the animal then removed bodily into the cage. When subjected to such treatment, first of all it growls, then gives the distress sound of *kree-kree-kree-kree*, and when it finds itself helpless it sends out an S.O.S. closely resembling the mewing of a cat, *mee-a-o*, *mee-a-o*, *mee-a-o*.

Intelligence

The underlying factor in the evolution of primates is the increased function of the brain that has excelled all other animals. This is often evident in their power to respond to and overcome the difficulties of environment. In the loris, with such keen powers of vision and hearing, the rapid association of these two faculties with muscular movements seems to be not vital enough to constitute any recognisable factor of memory or experience. My observations lead me to record that in *Loris tardigradus* the power to respond to and overcome difficulties that come out of environments, and the power of memory in order to regulate its actions by what it has already experienced under similar circumstances are very poor. I record below two of the experiments conducted.

The door of the cage was kept ajar just sufficient for the animal to put its forelimbs through, but not the head. When such situations were presented, the loris put out its hands and when it found that the gap was not wide enough for its head to go through, it withdrew its hands and retreated into the cage. Although the door could be easily opened with the slightest push to allow its exit, the animal did not even attempt it. The same situation was presented several times and the result was the same. To give it an indication of the ease with which the door could be pushed open, when the loris was trying to put its head through the gap the door was opened allowing it to come out. This was repeated six times. On the seventh time, I did not open the door and wanted to see whether the animal would push it open himself. It did not. This unmistakably indicated its failure to overcome the difficulty presented by its surroundings. It lacked the curiosity of the monkey, for instance, which under similar circumstances would have taken the first chance to break out.

For the close examination of the loris, I used to scoop it out in a strong butterfly net having a wide mesh, so that I could pull out its limbs through the mesh and inspect them, avoiding the possibility of its bites. Even after several such examinations the animal does not seem to remember the experience, and whenever the net is brought in front of it, it does not bolt away but calmly walks into it.

POWERS OF ATTACK AND DEFENCE

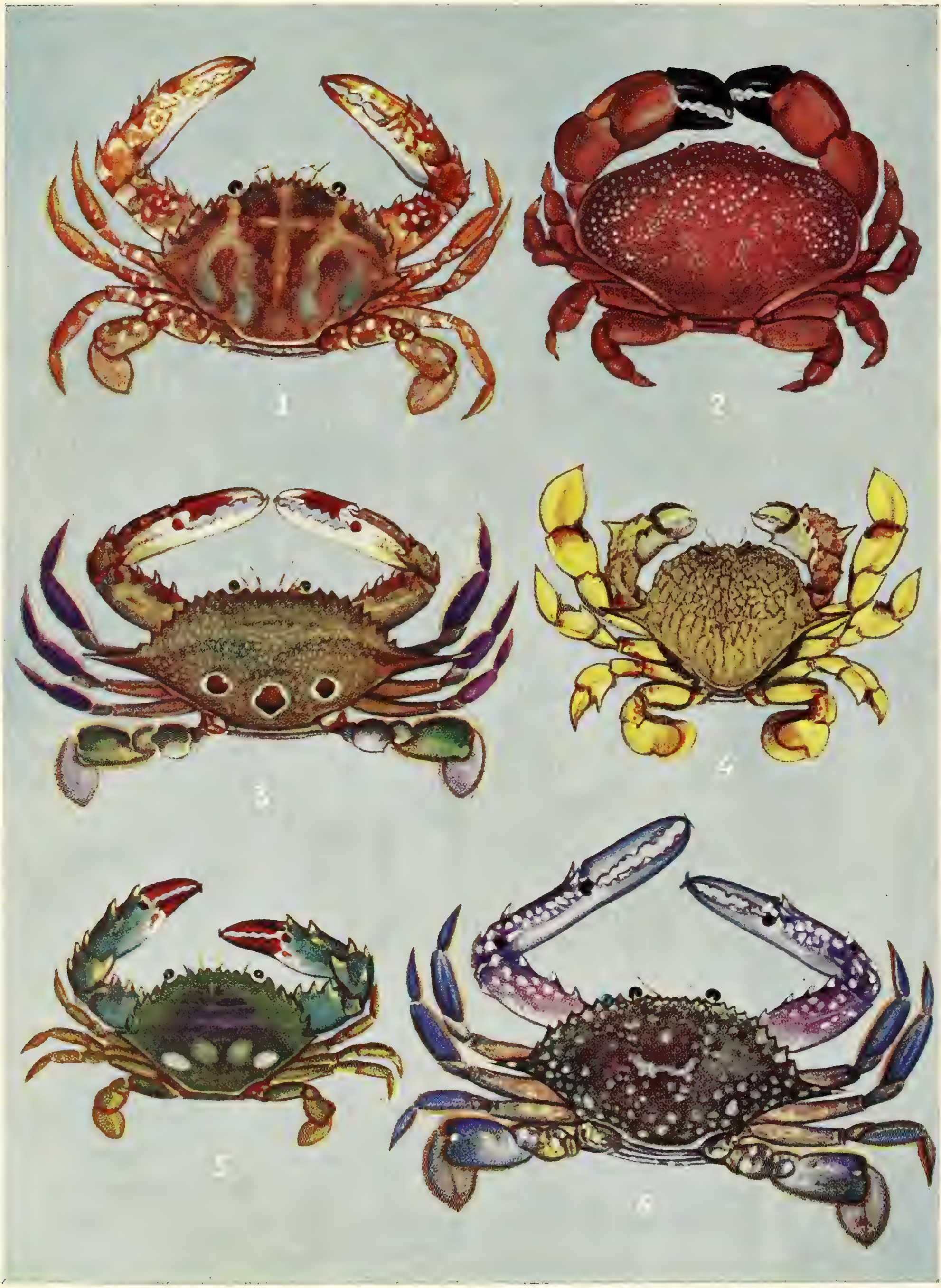
An animal with long limbs, a shapely trunk with broad chest, and narrow waist generally gives an impression of agility. But *Loris tardigradus* falsifies this impression. Its limbs with specialised modification for prehension do not endow the animal with any agility. Its movements both on the ground and on the branches of trees are slow. A predatory animal which could prey on the loris would find it easy to chase and catch it. For both attack and defence an animal depends upon its claws or nails and powerful jaws. The loris has harmless nails, and only one claw on the second digit of the legs which cannot be put into action as the legs are predominantly concerned in maintaining a grip on the branches. As for the jaws, they are useful only when furnished with powerful incisors or canines. It is observed that the incisors of the loris are ineffective, and of the canines only the lower pair seems to be effective. Observations tend to show that *Loris tardigradus* is very poorly endowed with powers of attack or defence.

REFERENCES

1. Schultz, A. H. (1945): Morphological Observations on the Gorilla.

2. Morton (1924): Evolution of Human Foot. *American Journal of Phys. Anthrop.* vii.

3. Le Gros Clark: Early forerunners of Man.



1. *Charybdis* (*Goniosoma*) *cruciata* $\times \frac{2}{5}$.
2. *Atergatis integerrimus* $\times \frac{1}{2}$.
3. *Neptunus* (*Neptunus*) *sanguinolentus* $\times \frac{3}{4}$.
4. *Matuta planipes* $\times 1\frac{1}{4}$.
5. *Charybdis* (*Goniosoma*) *lucifera* $\times \frac{1}{2}$.
6. *Neptunus* (*Neptunus*) *pelagicus* $\times \frac{2}{5}$.

ON THE MARINE CRABS (DECAPODA : BRACHYURA) OF BOMBAY STATE*

By

B. F. CHHAPGAR, M.SC.,

Taraporevala Marine Biological Station, Bombay

PART I

(*With one coloured and eleven line plates, and two text figures*)

INTRODUCTION

The study of the brachyuran fauna of the Indian seas has been comparatively restricted so far. Milne-Edwards (1832), de Man (1887), Henderson (1888), and others have published several reports on Brachyura, but this work was mostly confined to the investigation of species inhabiting the deep seas. Alcock also made extensive collections on the Indian Marine Survey Ship 'Investigator' as well as in India. His observations are recorded in his monumental publications (1895-1900), which are invaluable for a systematic study of crabs of the Indo-Pacific region. Additional observations by Gravely (1927), Kemp (1915-1919), Chopra (1930-1937), and Das (1930 and 1937) have also contributed considerably to our knowledge of Indian Brachyura; but the papers deal mostly with crabs of the eastern coast of India and the Bay of Bengal.

The brachyuran fauna of the west coast of the Indian subcontinent has not received much attention in the past except from Kohli (1921-1922), who described the crabs of Karachi. The only other work is that of Pillai (1951), who has described the crabs of Travancore. Karachi and Travancore represent the farthest extremities of the western coast of undivided India. The vast intermediate area has remained unexplored, except for a few isolated specimens recorded by Alcock and Chopra. It was, therefore, considered necessary that a representative collection of the crabs of Bombay State should be studied to augment our knowledge of this group on the west coast of India.

As it was not possible to make a comprehensive study of the crab fauna from the entire coast, collections were confined to localities selected to represent the various environmental conditions, such as sandy beaches, rocky foreshores, mud flats, marshes, mangrove swamps, etc. The localities of collection were Okha, Kodinar, Udvada, Kolak, Umarsadi, Bulsar,

---

* as it existed up to 31st October, 1956.

Bombay, Mithbao, Jaitapur, Ratnagiri, and Karwar along the coastal strip (see map).

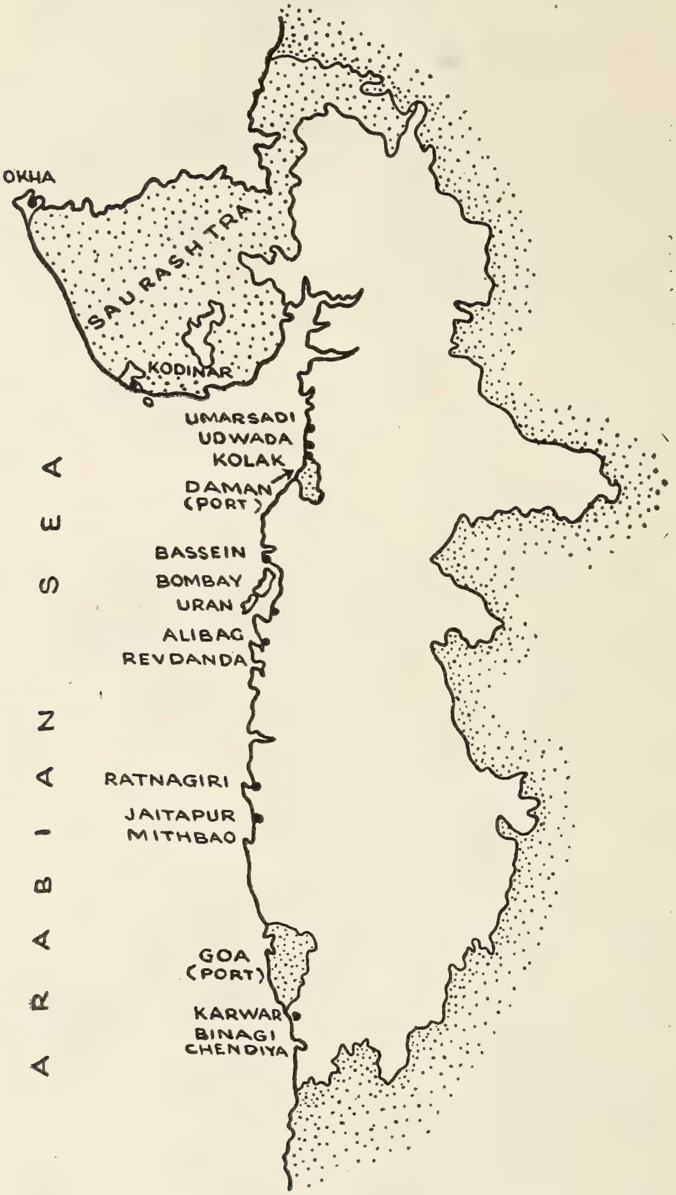

OKHA
SAURASHTRA
KODINAR
UMARSADI
UDWADA
KOLAK
DAMAN (PORT)
BASSEIN
BOMBAY
URAN
ALIBAG
REVDANDA
RATNAGIRI
JAITAPUR
MITHBAO
GOA (PORT)
KARWAR
BINAGI
CHENDIYA
ARABIAN SEA

Fig. 1. Map of Bombay State showing Localities of Collection.

MATERIALS AND METHODS

Specimens were collected mainly from the inter-tidal zone exposed during ebb tides as well as from the catches of inshore fishermen. The collections were made in all seasons. Though extensive collections were made in inshore waters, lack of facilities prevented collection of material from the deep-sea. A few deep-sea forms were, however, made available for study by the Japanese trawler 'Taiyo' Maru No. 17, from the Gulf of Cutch.

The specimens were examined on the same day as collected, then preserved in 70% alcohol, and later examined again in detail.

It was seen that killing the crabs even in weak alcohol or formalin solutions caused them to shed their legs or chelae; to prevent this, they were numbed by freezing in a refrigerator for a few hours, then taken out and preserved in 70% alcohol.

Miss Gordon[1] has directed attention to the importance of studying the abdominal appendages of the male in view of their providing characters of considerable systematic value, and Chopra has followed the same line of study. The author too has paid special attention to these appendages, and has found them to afford, in many cases, useful characters in separating closely allied species.

The author has adhered to the terminology and classification used by Alcock in his 'Materials for a Carcinological Fauna of India.'

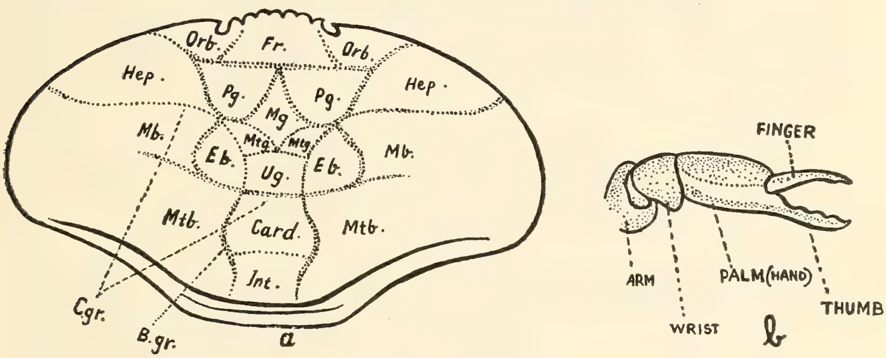


Fig. 2

Diagram of (*a*) Carapace and (*b*) Cheliped of a crab :

B. Gr.—Branchio-cardiac groove. *Card.*—Cardiac region. *C. Gr.*—Cervical groove. *Eb.*—Epibranchial region. *Fr.*—Frontal region. *Hep.*—Hepatic region. *Int.*—Intestinal region. *Mb.*—Mesobranchial region. *Mg.*—Mesogastric region. *Mtb.*—Metabranchial region. *Mtg.*—Metagastric region. *Orb.*—Orbital region. *Pg.*—Protogastric region. *Ug.*—Urogastric region.

SYSTEMATICS

Tribe DROMIACEA

Subtribe DROMIIDEA

Family *DROMIIDAE*

Genus **Dromia** Fabricius

Dromia dormia (Linnaeus)

(Plate 1)

Dromia rumphii, De Haan, *Fauna Japonica* v, p. 107 (1850).
Walker, *Journ. Linn. Soc. London* (*Zool.*) xx, p. 111 (1890).

---

[1] Gordon, I., *Journ. Linn. Soc. London* (*Zool.*) 37, pp. 525, 526 (1931).

Henderson, *Trans. Linn. Soc. London (Zool.)* v, p. 406 (1893).
Alcock, *Journ. As. Soc Bengal* lxviii, p. 137 (1899).
Alcock, *Catal. Ind. Dec. Crust.* Pt I, p. 44 (1901).
Borradaile, *Fauna Geog. Malaive and Laccadive Archipel.* (2) I, p. 577 (1903).
Pillai, *Bull. Central Inst. Travancore* ii, p. 24 (1951).
Dromia dormia, Ihle, *Siboga Exped. Rep.* xxxix, p. 22 (1913).
Shen, *Hong Kong Nat.* ii, p. 96 (1931).
Barnard, *Ann. Mag. nat. hist.* xiii, p. 366 (1946).

The species is represented in the collection by a female from Bombay. Its dimensions are :—

length of carapace	...	43 mm.
breadth of carapace	...	51 mm.

This species can be distinguished by the carapace being broader than long, and the front being cut into three nearly equal teeth. The antero-lateral borders are cut into three teeth. The third pair of legs are hardly shorter than the last, and there is no spine at the far end of the posterior border of the last pair.

Colour harsh grey, fingers of the chelipeds pink.

This species has been previously recorded from the Red Sea, Persian Gulf, South Africa, Mauritius, both the coasts of India, Laccadives and Maldives, China, and Japan.

Genus **Pseudodromia** Stimpson

Pseudodromia integrifrons Henderson

(Plate 1)

Pseudodromia integrifrons, Henderson, *Trans. Linn. Soc. London (Zool.)* v, p. 406 (1893).
Alcock, *Journ. As. Soc. Bengal* lxviii, p. 150 (1899).
Gordon, *Sci. Rep. John Murray Exped.* (1) ix, p. 209 (1950).
Pseudodromia caphyraeformis, Balss, *Zool. Anz. Leipzig* liii, p. 110 (1922).

Thirteen mature specimens, of both sexes, were collected at Okha among pebbles and weeds in the inter-tidal zone. A large, berried female gave the following measurements :—

length of carapace.. ..	7.75 mm.
breadth of carapace....	5.75 mm.

The carapace is smooth and polished, subpentagonal, regularly convex both transversely as well as longitudinally, and is very sparingly pubescent. The cervical and branchio-cardiac grooves are well-marked, the latter indenting the lateral margin of the carapace behind its middle. The lateral borders are long and entire, somewhat ill-defined, parallel for more than half their posterior extent, then abruptly turned inward and downward to end in a down-turned, simple, triangular acute rostrum. The subhepatic region has two slight subparallel sulci, the upper of which is very short and contains a fissure passing back from the poorly marked external orbital angle. The entire border of the carapace is fringed with silky hairs, which are longer and more dense between the orbits and are very dense at the rostrum.

The eyes and antennules fold into common orbito-antennulary pits. The eyes are somewhat elongated, the lower orbital margin being formed simply by the antennal peduncle. The rostrum, when viewed from below, is seen to have an inferior vertical extension, which partly separates the antennules, but which is not joined to the epistome, although it comes very close to it. The antennal flagellum consists of about 25 segments, the second segment being twice as long as wide. There are eight gills and three epipodites.

The chelipeds and legs are covered with a short pubescence, which is most dense on the former. The chelipeds, with the exception of the fingers, are devoid of tubercles or teeth; the hand is only slightly dilated. The movable finger has a few small teeth proximally and two larger ones at the tip. The thumb has three enlarged teeth. The tip of the finger shuts into a notch in the tip of the thumb, the last tooth of the latter being double-pronged. Both the fingers are slightly hollowed at the tips, and gape proximally.

The first three pairs of legs are covered with coarse, long, downwardly directed hairs. The meri of the first three pairs of legs have, in addition, fringes of very long, barbed hairs on both the borders; the anterior borders of the meri of these legs have the slightest indication of serration. The dactyli of the first three pairs of legs are strongly curved, horny, and have short, horny spinules on their inner border. The third pair also has a prominent lobe at the outer distal end of the carpus. The elongated last pair of legs are subdorsal and are the longest. Their merus is curved elegantly, and has both the borders fringed with silky hairs. The borders of the carpopodites and propodites are also covered with hairs, but not so densely as in the other legs; moreover, the hairs are directed upward. Their carpal joint lies on the branchial region of the carapace over the cervical groove. The dactylus of the last pair of legs is straight, not curved. The distal end of the propodites is provided with two long and two short spines arranged in a ring, on which the dactylus can shut down.

The distal ends of the carpopodites and propodites of all the legs are clothed in a ring of longer, stiff hairs, as also is the dactylus of the last pair in its middle.

The abdomen consists of seven separate segments in both sexes. There are no lateral platelets. The sternum of the female is traversed longitudinally by a pair of grooves that end in tubercles at the level of the bases of the first pair of legs. The ova are large, 1.0 mm. × 0.8 mm.

Colour of the (cleaned) carapace greyish orange, the denuded legs and fingers of the chelae with orange and white stripes.

The crab is protected by a colonial Ascidian.

Only two females, the co-types of this species, are known so far, having been recorded from Tuticorin. This is the first record of this species from the west coast of India, as well as *the first record of the male throughout the world.*

The male is much smaller than the female, being about two-third the length of the latter. It resembles the female in all its characters, except that the lateral borders of the carapace are more thickly fringed with hair, and the chelipeds are comparatively slightly stouter.

The abdomen is narrower than in the female, and consists of seven segments. The genital ducts of the male open on the bases of the last pair of legs. The male has the usual two pairs of copulatory abdominal appendages. The first is stout, with a thin tip bearing a brush of setae. The second is thin, with a globular tip, and has three plumose hairs near its middle.

Tribe OXYSTOMATA

Family *CALAPPIDAE*

Subfamily CALAPPINAE

Genus **Calappa** Fabricius

Calappa lophos (Herbst)

(Plate 1)

Calappa (*Lophos*) *lophos*, De Haan, *Fauna Japonica* v. p. 72 (1850).
Calappa lophos, Walker, *Journ. Linn. Soc. London* (*Zool.*) xx, p. 111 (1890).
Henderson, *Trans. Linn. Soc. London* (*Zool.*) v, p. 395 (1893).
Alcock and Anderson, *Journ. As. Soc. Bengal* lxiii, p. 203 (1894).
Alcock, *Journ. As. Soc. Bengal* lxv, p. 144 (1896).
Laurie, *Ceylon Pearl Oyster Fish. Report* (5) p. 353(1906).
Ihle, *Siboga Exped. Rep.* xxxix, p. 182 (1918).
Rathbun, *Dept. of Trade and Customs* (*Fish.*) *Commonwealth of Australia* v, p. 137 (1923).
Chopra, *Rec. Ind. Mus.* xxxv, p. 28 (1933).
Shen, *Chin. Journ. Zool.* ii, p. 64 (1936).
Sakai, *Sci. Rep. Tokyo Bun. Daig.* (3), p. 90 (1938).
Shen, *Bull. Fan Mem. Inst. Biol.* (*Zool.*) x, p. 76 (1940).
Barnard, *Ann. Mag. nat. hist.* xiii, p. 372 (1946).
Barnard, *Ann. S. Afr. Mus.* xxxviii, p. 351 (1950).
Suvatti, *Dept. of Fisheries, Bangkok, Thailand*, p. 148 (1950).
Pillai, *Bull. Central Inst. Travancore* ii, p. 8 (1951).

Some specimens were collected at Bombay, Ratnagiri, and Karwar. It lives in sandy or muddy regions. An average female measures :—

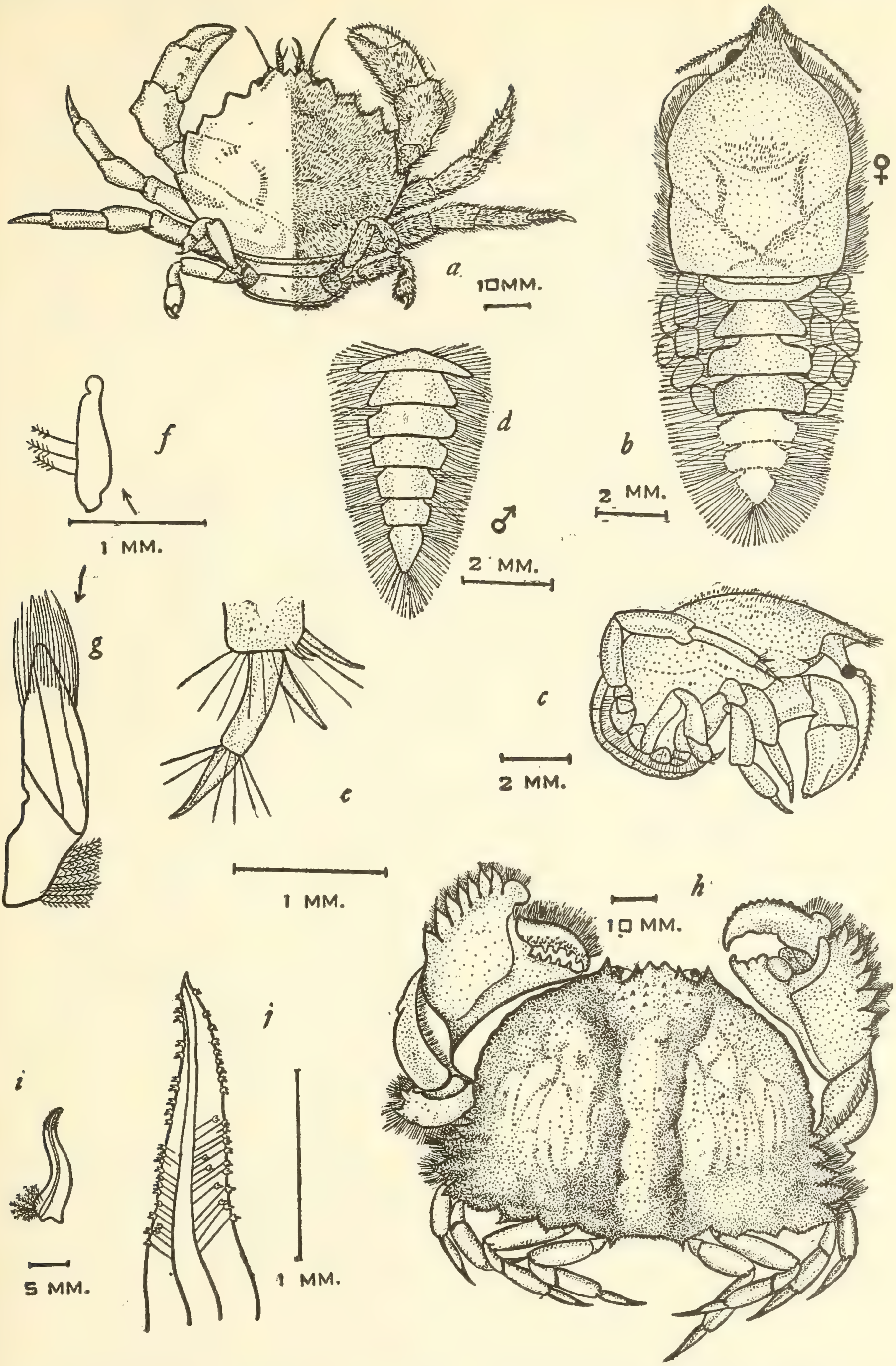
length of carapace	... 59 mm.
breadth of carapace	... 90 mm.

This species is distinguished by the smoothness of the carapace in the adult, the extreme length of which is about two-third its extreme breadth. The clypeiform expansions are well-developed, their free margins being strongly laciniate. There is no spine on the posterior border of the carapace in the middle. The anterior border of the endostomial septum is deeply concave.

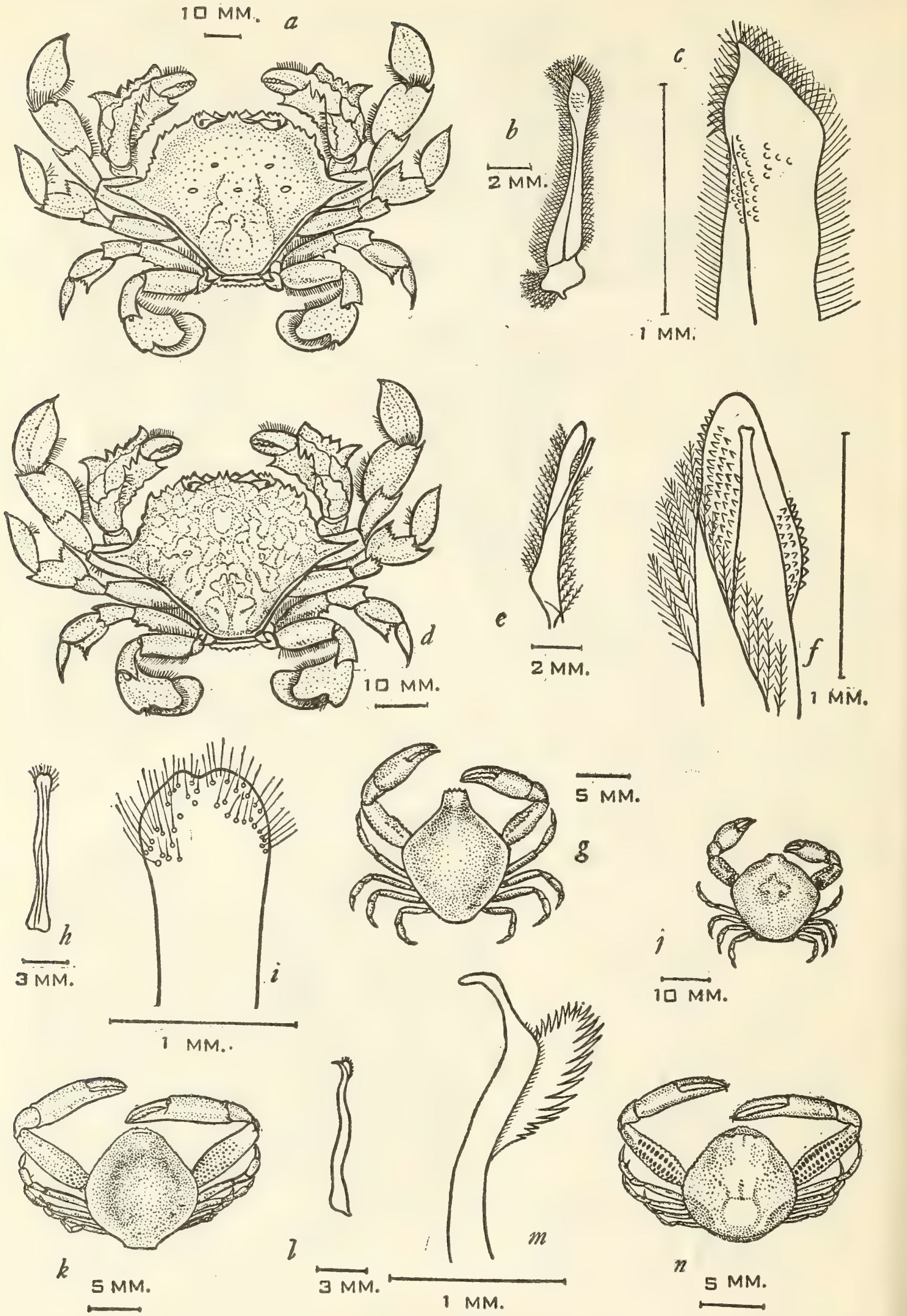
Colour pinkish, the fingers of the chelipeds yellow.

In a female specimen in the present collection, there is a curved line of red ocelli present during life (although the female is an adult); this disappears in spirit. Also, there is a toothed ridge near the lower border of the palm.

This species occurs commonly along the eastern coast of India, from the delta of the Hughli to as far south as Pondicherry. It has also been recorded from Travancore, the Andamans, Ceylon, Laccadives, Persian Gulf, Dar-es-Salam, Siam, Japan, Celebes, Amboina, and Australia. This is the first record of this species from Bombay State.


a
10MM.
b
♀
2 MM.
d
♂
2 MM.
f
1 MM.
g
e
1 MM.
c
2 MM.
h
10 MM.
i
5 MM.
j
1 MM.

a. Dromia dormia (Linnaeus), dorsal view. *b. Pseudodromia integrifrons* Henderson. Berried female, dorsal view. *c.* Same, side view. *d.* Abdomen of male. *e.* Tip of fourth walking leg. *f.* 2nd left abdominal appendage of male. *g.* 1st left abdominal appendage of male. *h. Calappa lophos* (Herbst). Dorsal view of crab. *i.* 1st left abdominal appendage of male. *j.* Tip of same, enlarged.


10 MM.
a
b
2 MM.
c
1 MM.
e
2 MM.
d
10 MM.
f
1 MM.
h
3 MM.
i
1 MM.
g
5 MM.
j
10 MM.
k
5 MM.
l
3 MM.
m
1 MM.
n
5 MM.

a. Matuta lunaris (Forskal). Dorsal view of crab. *b.* 1st left abdominal appendage of male. *c.* Tip of same, enlarged. *d. Matuta planipes* Fabricius. Dorsal view of crab. *e.* 1st left abdominal appendage of male. *f.* Tip of same, enlarged. *g. Leucosia pubescens* Miers. Dorsal view of crab. *h.* 1st left abdominal appendage of male. *i.* Tip of same, enlarged. *j. Leucosia sima* Alcock, dorsal view. *k. Philyra globosa* (Fabricius). Dorsal view of crab. *l.* 1st left abdominal appendage of male. *m.* Tip of same, enlarged. *n. Philyra corallicola* Alcock, dorsal view.

Subfamily MATUTINAE

Genus **Matuta** Milne-Edwards

Matuta lunaris (Forskal)

(Plate 2)

Matuta victor, De Haan, *Fauna Japonica* v, p. 127 (1850).
Alcock, *Journ. As. Soc. Bengal* lxv, p. 160 (1896).
Kemp, *Mem. Ind. Mus.* v, p. 209 (1915).
Kohli, *Proc. Lahore Phil. Soc.* iii, p. 83 (1921–1922).
Gravely, *Bull. Madras Govt. Mus.* i, p. 142 (1927).
Suvatti, *Dept. of Fisheries, Bangkok, Thailand,* p. 148 (1950).
Matuta victrix, Haswell, *Catalogue Austr. Crust.*, p. 133 (1882).
Walker, *Journ. Linn. Soc. London* (*Zool.*) xx, p. 111 (1890).
Henderson, *Trans. Linn. Soc. London* (*Zool.*) v, p. 396 (1893).
Alcock and Anderson, *Journ. As. Soc. Bengal* lxiii, p. 203 (1894).
Lanchester, *Proc. Zool. Soc. London,* p. 762 (1900).
Matuta lunaris, Laurie, *Ceylon Pearl Oyster Fish. Report* (5), p. 356 (1906).
Ihle, *Siboga Exped. Rep.* xxxix, p. 185 (1918).
Chopra, *Rec. Ind. Mus.* xxxv, p. 31 (1933).
Chopra and Das, *Rec. Ind. Mus.* xxxix, p. 282 (1937).
Sakai, *Sci. Rep. Tokyo Bun. Daig.* (2) liii, p. 100 (1937).
Shen, *Bull. Fan Mem. Inst. Biol.* (*Zool.*) x, p. 77 (1940).
Barnard, *Ann. S. Afr. Mus.* xxxviii, p. 358 (1950).
Pillai, *Bull. Central Inst. Travancore* ii, p. 9 (1951).

Numerous specimens, of both sexes, were collected at Bombay, Karwar, Okha, and Umarsadi. It lives in sandy and muddy regions.

This species is distinguished by the presence of a distinct spine at the angle of the hand where it comes in contact with the external angle of the arm. The length of the composite segment 3–5 in the male is greater than its breadth at the base, and the length of the terminal segment is considerably more than its posterior breadth.

Colour yellow, with a multitude of violet speckles—these fade into a red tint in spirit.

An average male gave the following measurements :—

length of carapace	... 38 mm.
breadth of carapace (excluding lateral spines)	... 35 mm.
length of lateral spine	... 12 mm.
posterior breadth of composite segment 3-5	... 8.75 mm.
median length of composite segment 3–5	... 11.0 mm.
posterior breadth of segment 7	... 3.0 mm.
median length of segment 7	... 4.75 mm.

In the specimens in the present collection, it was found that the speckles on the carapace were of two types, viz. (1) very minute dots, and (2) coarse speckles. Examination of a large number of specimens indicated that the ratio of crabs having minute dots to those with coarse speckles was roughly 1 : 2. A differentiation in the direction of spines was also noticed, some pointing forward, some laterally, and some even backward.

The anterior male appendage is straight, shaped like an arrowhead at the tip, where there are numerous blunt spinules, tubercles, and hairs.

This crab takes the place of *Varuna litterata* (Fabricius) in Bengal in being used as the poor man's food in Bombay.

It is a very common species, having been previously recorded from various localities from Polynesia in the east to as far as the Red Sea and the Cape region on the west. In India it has been recorded from both the

Bay of Bengal and the Arabian Sea. This is the first record in Bombay State.

Matuta planipes Fabricius

(Plate 2)

Matuta lunaris, Walker, *Journ. Linn. Soc. London (Zool.)* xx, p. 111 (1890).
Henderson, *Trans. Linn. Soc. London (Zool.)* v. p. 396 (1893).
Alcock, *Journ. As. Soc. Bengal* lxv, p. 161 (1896).
Lanchester, *Proc. Zool. Soc. London*, p. 763 (1900).
Suvatti, *Dept. of Fisheries, Bangkok, Thailand*, p. 148 (1950).
Matuta planipes, Rathbun, *Dept. of Trade and Customs (Fish.) of Commonwealth of Australia* v, p. 138 (1923).
Chopra, *Rec. Ind. Mus.* xxxv, p. 32 (1933).
Chopra and Das, *Rec. Ind. Mus.* xxxix, p. 384 (1937).
Sakai, *Sci. Rep. Tokyo Bun. Daig.* (2) iii, p. 101 (1937).
Shen, *Inst. Zool. Nat. Acad. Peiping* iii, p. 172 (1937).
Shen, *Bull. Fan Mem. Inst. Biol. (Zool.)* x, p. 77 (1940).
Shen, *Inst. Zool., Nat. Acad. Peiping* iv, p. 106 (1948).
Pillai, *Bull. Central Inst. Travancore* ii, p. 10 (1951).
Matuta flagra, Shen, *Chin. Journ. Zool.* ii, p. 64 (1936).

Two female specimens from Bombay and Bassein and a male from Bombay are in the present collection. The measurements of one of them are given here :—

length of carapace ...	29 mm.
breadth of carapace (excluding lateral spines) ...	23 mm.
length of lateral spine ...	8 mm.

There is no spine, only a tubercle, at the angle of the hand where it touches the external angle of the arm.

Colour of the carapace bright yellow with vermicular red lines, which usually form spots or incomplete rings on the anterior half of the carapace and narrow longitudinal loops posteriorly.

This species has been previously recorded from the mouth of the Hughli, Mergui, Andamans, Burma, along both the coasts of Peninsular India, Cape of Good Hope, Singapore, Siam, China, Japan, Java, Celebes, and NW. Australia. This is the first record from Bombay State.

Family *LEUCOSIIDAE*

Subfamily LEUCOSIINAE

Genus **Leucosia** Fabricius

Leucosia pubescens Miers

(Plate 2)

Leucosia pubescens, Haswell, *Catalogue Austr. Crust.*, p. 119 (1882).
Alcock, *Journ. As. Soc. Bengal* lxv. p. 233 (1896).
Laurie, *Ceylon Pearl Oyster Fish. Report* (5), p. 363 (1906).
Ihle, *Siboga Exped. Rep.* xxxix, p. 282 (1918).

Two males from Bombay are in the present collection. One of them measures :—

length of carapace ...	19 mm.
breadth of carapace ...	16 mm.

It is distinguished by the sharply hexagonal carapace, which is six-seventh as long as broad. The front is about as long as broad, with its sides subparallel. The thoracic sinus is shallow. The male abdomen consists of three segments.

Colour light slaty blue, chelipeds and legs with brownish bands.

The anterior male appendages are straight with a curious twist in the middle. Their tips are bilobed and bear brushes of hairs.

This species has been previously recorded from the Persian Gulf, Madras coast, Gulf of Manaar, Andamans, Thailand, Mergui, Hong Kong, and Australia. This is the first record from the west coast of India.

Leucosia sima Alcock

(Plate 2)

Leucosia sima, Alcock, *Journ. As. Soc. Bengal* lxv, p. 227 (1896).

This species is represented in the present collection by a female from Okha. It measures :—

length of carapace	... 13 mm.
breadth of carapace	... 14 mm.

The carapace in this crab is a little broader than long and almost pentagonal. The antero-lateral borders appear convex due to the strongly marked angular projection of the hepatic region. The posterior border is longer than half the greatest breadth of the carapace. The front is hardly prominent beyond the hepatic regions. The hand of the chelipeds is about twice as long as the fingers.

Colour light chocolate brown.

In the present specimen, the carapace is pitted throughout, and the front is very obscurely quadridentate.

This species has been previously recorded from Bombay by Alcock.

Genus **Philyra** Leach

Philyra globosa (Fabricius)

(Plate 2)

Philyra globosa, de Man, *Journ. Linn. Soc. London* (*Zool.*) xxii, p. 202 (1887).
Henderson, *Trans. Linn. Soc. London* (*Zool.*) v, p. 401 (1893).
Alcock, *Journ. As. Soc. Bengal* lxv, p. 243 (1896).
Lanchester, *Proc. Zool. Soc. London*, p. 764 (1900).
Laurie, *Ceylon Pearl Oyster Fish Report* (5), p. 364 (1906).
Chopra, *Rec. Ind. Mus.* xxxv, p. 271 (1933).
Barnard, *Ann. Mag. nat. hist.* xiii, p. 373 (1946).
Barnard, *Ann. S. Afr. Mus.* xxxviii, p. 330 (1950).

Numerous specimens, of both sexes, were collected at Bombay. It frequents sandy places. An average male measures :—

length of carapace	... 16 mm.
breadth of carapace	... 16 mm.
length of cheliped	... 32 mm.
length of finger of cheliped	... 7 mm.
length of outer border of hand	... 7 mm.

The carapace is subcircular, almost smooth. Its border is defined by a line of uniformly sized beads. The epistome projects well beyond the edge of the front, and its margin is not cleft below the eye. The terminal segment of the exognath of the external maxillipeds is semicircular. The hand of the chelipeds is very slightly longer than broad.

Colour smoky bluish brown above, the blue deepest on the carapace.

The anterior male abdominal appendage is broad at the base and abruptly narrows half the way; the tip is bent suddenly and bears numerous spines on a lobule just like a cock's comb.

This species has been previously recorded from various places along the east coast of India, from the mouth of the Hughli to Madras, and from Karachi. This is the first record from Bombay State.

Philyra corallicola Alcock

(Plate 2)

Philyra corallicola, Alcock, *Journ. As. Soc. Bengal* lxv, p. 247 (1896).

Two females from Bombay and Ratnagiri represent the present collection. It lives in burrows in sand. The larger one measures :—

length of carapace	...	8.0 mm.
breadth of carapace	...	8.5 mm.

The carapace is circular. The hepatic regions form a pair of distinct dorsal swellings. These and the posterior part of the gastric region, as well as the convexities of the other regions, are covered with large vesiculous granules.

Colour sandy brown.

This species has been previously recorded from the Malabar coast. This is the first record from Bombay State.

Subfamily ILIINAE

Genus **Arcania** Leach

Arcania septemspinosa (Fabricius)

(Plate 3)

Arcania septemspinosa, Henderson, *Trans. Linn. Soc. London* (*Zool.*) v, p. 403 (1893).
Alcock, *Journ. As. Soc. Bengal* lxv, p. 265 (1896).
Ihle, *Siboga Exped. Rep.* xxxix, p. 265 (1918).
Chopra, *Rec. Ind. Mus.* xxxv, p. 43 (1933).
Shen, *Bull. Fan Mem. Inst. Biol.* (*Zool.*) x, p. 77 (1940).
Barnard, *Ann. Mag. nat. hist.* xiii, p. 375 (1946).
Suvatti, *Dept. of Fisheries, Bangkok, Thailand,* p. 147 (1950).

A male was caught off the Gulf of Cutch at a depth of 25 fathoms. It lives on muddy bottom. It measures :—

length of carapace (excluding the spines)	...	21 mm.
breadth of carapace (excluding the spines)	...	22 mm.
length of lateral spine	...	16 mm.
length of cheliped	...	55 mm.

The carapace is bluntly rhomboidal, its surface being finely granular in irregular patches. There are seven spines on its margins, the lateral ones being the longest. The fingers of the chelipeds are longer than the hand. The male abdomen consists of five segments.

Colour streaky and patchy red.

In the specimen in the present collection, the posterior spine is broken off and indicated by a hole ; the fingers of the right claw are also partially broken. There is a spinule at the base of the merus of the chelipeds. The lateral spines are only two-third the length of the carapace. The tubercles on the merus and exognath of the external maxillipeds indicated by Chopra (1933) are present.

The anterior male abdominal appendage is straight ; it is narrowed and spooned at the tip, and bears numerous long hairs near the end.

This species has been previously recorded from the Andamans, the Arakan coast, the delta of the Ganges, all along the east coast of India, Persian Gulf, Cape of Good Hope, Red Sea, Malay Archipelago, and Hong Kong. This is the first record from the west coast of India.

Family *DORIPPIDAE*

Subfamily DORIPPINAE

Genus **Dorippe** Fabricius

Dorippe astuta Fabricius

(Plate 3)

Dorippe astuta, de Man, *Journ. Linn. Soc. London* (*Zool.*) xxii, p. 405 (1887).
Walker, *Journ. Linn. Soc. London* (*Zool.*) xx, p. 111 (1890).
Alcock, *Journ. As. Soc. Bengal* lxv, p. 280 (1896).
Lanchester, *Proc. Zool. Soc. London*, p. 769 (1900).
Shen, *Bull. Fan Mem. Inst. Biol.* (*Zool.*) x, p. 76 (1940).

This species is represented by a male from Bombay. It measures :—

length of carapace ...	11.50 mm.
breadth of carapace ...	10.75 mm.

The carapace is smooth, and flat, and is slightly longer than broad. The body and appendages are covered with short, distant hairs. The spine at the inner canthus of the orbit is rudimentary. The last pair of legs is more than half the length of the second.

Colour ashy grey.

The anterior male appendage is shaped at the tip like a tin-opener, with one crescentic tip, and the other bent over itself.

This species has been previously recorded from the Andamans, Mergui, Orissa coast, Karachi, and China. This is the first record from Bombay State.

Tribe BRACHYGNATHA

Subtribe OXYRHYNCHA

Family *HYMENOSOMIDAE*

Genus **Elamena** Milne-Edwards

Elamena cristatipes Gravely

(Plate 3)

Elamena cristatipes, Gravely, *Bull. Madras Govt. Mus.* i, p. 150 (1927).
Chopra and Das, *Rec. Ind. Mus.* xxxii, p. 425 (1930).
Pillai, *Bull. Central Inst. Travancore* ii, p. 33 (1951).

Numerous specimens, of both sexes, were obtained from Bombay and Okha, living among rocks overgrown with sea-weeds. A typical male measures :—

length of carapace	...	6.5 mm.
breadth of carapace	...	5.0 mm.

This crab is distinguished by its pyriform carapace and rounded front. The walking legs are flattened, with a prominent crest at the distal part of the upper surface of the second and third joints. The dactylus is curved, its lower edge is sharp, and it is provided with two curved teeth at the tip.

The anterior male appendage is sinuous and is split to form two whip-like tips. They do not bear hairs.

This species has been previously recorded from the Gulf of Manaar, Madras, and Travancore. This is the first record from Bombay State.

Family *MAIIDAE*

Subfamily ACANTHONYCHINAE

Genus **Menaethius** Milne-Edwards

Menaethius monoceros Latreille

(Plate 3)

Menaethius monoceros, Haswell, *Catalogue Austr. Crust.*, p. 9 (1882).
Henderson, *Trans. Linn. Soc. London* (*Zool.*) v, p. 342 (1893).
Alcock, *Journ. As. Soc. Bengal* lxiv, p. 401 (1895).
Calman, *Trans. Linn. Soc. London* (*Zool.*) viii, p. 34 (1900).
Lanchester, *Proc. Zool. Soc. London*, p. 722 (1900).
Laurie, *Ceylon Pearl Oyster Fish. Report* (5) p. 375 (1906).
Chopra, *Rec. Ind. Mus.* xxxiii, p. 324 (1931).
Montgomery, *Journ. Linn. Soc. London* (*Zool.*) xxxvii, p. 417 (1931).
Sakai, *Sci. Rep. Tokyo Bun. Daig.* (3) iii, p. 263 (1938).
Barnard, *Ann. S. Afr. Mus.* xxxviii, p. 43 (1950).
Buitendijk, *Bull. Raffles Mus. Singapore* 21, p. 63 (1950).
Suvatti, *Dept. of Fisheries, Bangkok, Thailand*, p. 149 (1950).
Pillai, *Bull. Central Inst. Travancore* ii, p. 5 (1951).

This species is represented in the present collection by two males from Okha. The crab inhabits rocky regions overgrown with weeds, but Chopra (1931) has recorded a specimen from the cloaca of a Holothurian. The larger male measures :—

length of carapace	...	22 mm.
breadth of carapace	...	21 mm.
length of rostrum	...	8 mm.

The crab is distinguished by its elongate-triangular carapace, and the acute, styliform, horizontally compressed rostrum, flanked on either side by the forwardly directed supraocular spine.

Colour a pale lemon yellow.

The carapace is usually encrusted with weeds, and is very variable as regards the number, position, and size of the spines. In the specimens in the present collection, the tubercles on the carapace are arranged in a regular manner, viz. three in a triangle on the gastric region, three others forming a triangle on the cardiac region (three to four lateral spines on the antero-lateral borders), two on the branchial region, and a median intestinal one at the posterior end.

The carapace is finely granular under the microscope. The rostrum, which is as long as the carapace in some, varies greatly and in the present collection is only one-third the length of the carapace ; it is hairy, the hairs being of two types : (1) simple, (2) clubbed.

There are two to three hairy knobs on the anterior border of the meropodites of the legs, and one in the middle of the posterior border of the propodites. There is a spine-like tubercle near the base of the arm of the chelipeds.

The anterior male abdominal appendage is peculiar, its tip being at right angles to the body and shaped like a bird's head. The distal half of the appendage is abruptly narrowed.

According to Laurie (1906), the phenomenon referred to as 'facultative dimorphism' is observed in this species, viz. alternate phases in the life-history of the same individual co-related with the breeding and non-breeding period respectively, the breeding male with pronounced secondary sexual characters changed by a moult to the non-breeding form with much resemblance to the young.

This species is widely distributed, occurring throughout the Indo-Pacific region, in the Red Sea, Persian Gulf, east coast of Africa, both the coasts of India, Laccadives and Maldives, Andaman and Nicobar Is., Malay Archipelago, Japan, Fiji, and Hawaii. This is the first record from Bombay State.

Subfamily PISINAE

Genus **Hyastenus** White

Hyastenus planasius (Adams & White)

(Plate 3)

Hyastenus planasius, Walker, *Journ. Linn. Soc. London* (*Zool.*) xx, p. 109 (1890).
Alcock, *Journ. As. Soc. Bengal* lxiv, p. 212 (1895).
Buitendijk, *Bull. Raffles Mus. Singapore* 21, p. 63 (1950).
Suvatti, *Dept. of Fisheries. Bangkok, Thailand*, p. 150 (1950).
Pillai, *Bull. Central Inst. Travancore* ii, p. 6 (1951).

A male from Bombay and a female from Okha are in the present collection. The male measures :—

length of carapace (without rostrum) ...	25 mm.
breadth of carapace ...	20 mm.
length of rostrum ...	11 mm.
length of cheliped ...	36 mm.
length of second walking leg ...	50 mm.

This species can be distinguished by its elongate-ovate carapace, with a small epibranchial tubercle on each side, and the absence of an intestinal spine.

Colour ashy grey.

The specimens in the present collection agree with Buitendijk's description, having nine tubercles, viz. three gastric tubercles, behind these two small lateral ones, an indistinct cardiac, two on the hinder slope, and a prominent intestinal tubercle.

The anterior male abdominal appendage is shaped at the tip like a barbed hook.

This species has been previously recorded from Ceylon, Mergui, Travancore, Arakan coast, and Singapore. This is the first record from Bombay State.

Genus **Doclea** Leach

Doclea gracilipes Stimpson

(Plate 3)

Doclea sp., de Man, *Journ. Linn. Soc. London* (*Zool.*) xxii, p. 13 (1887).
Doclea gracilipes, Alcock, *Journ. As. Soc. Bengal* lxiv, p. 229 (1895).
Laurie, *Ceylon Pearl Oyster Fish. Report* (5), p. 381 (1906).
Chopra, *Rec. Ind. Mus.* xxxvii, p. 470 (1935).
Shen, *Bull. Fan Mem. Inst. Biol.* (*Zool.*) x, p. 80 (1940).

Numerous specimens, of both sexes, were collected at Bombay. It lives among rocks encrusted with weeds. A large male measures :—

length of carapace (from the base of the rostrum to the base of the median posterior spine)	38 mm.
breadth of carapace	35 mm.
length of rostrum	6 mm.
length of median posterior spine	4 mm.
length of second leg	126 mm.

It is a variable species, but it can be distinguished by the following characters, which are constant :—

(1) the discoid (non-globose) carapace, with elevations only on the middle line ;

(2) the long slender legs of the second pair ;

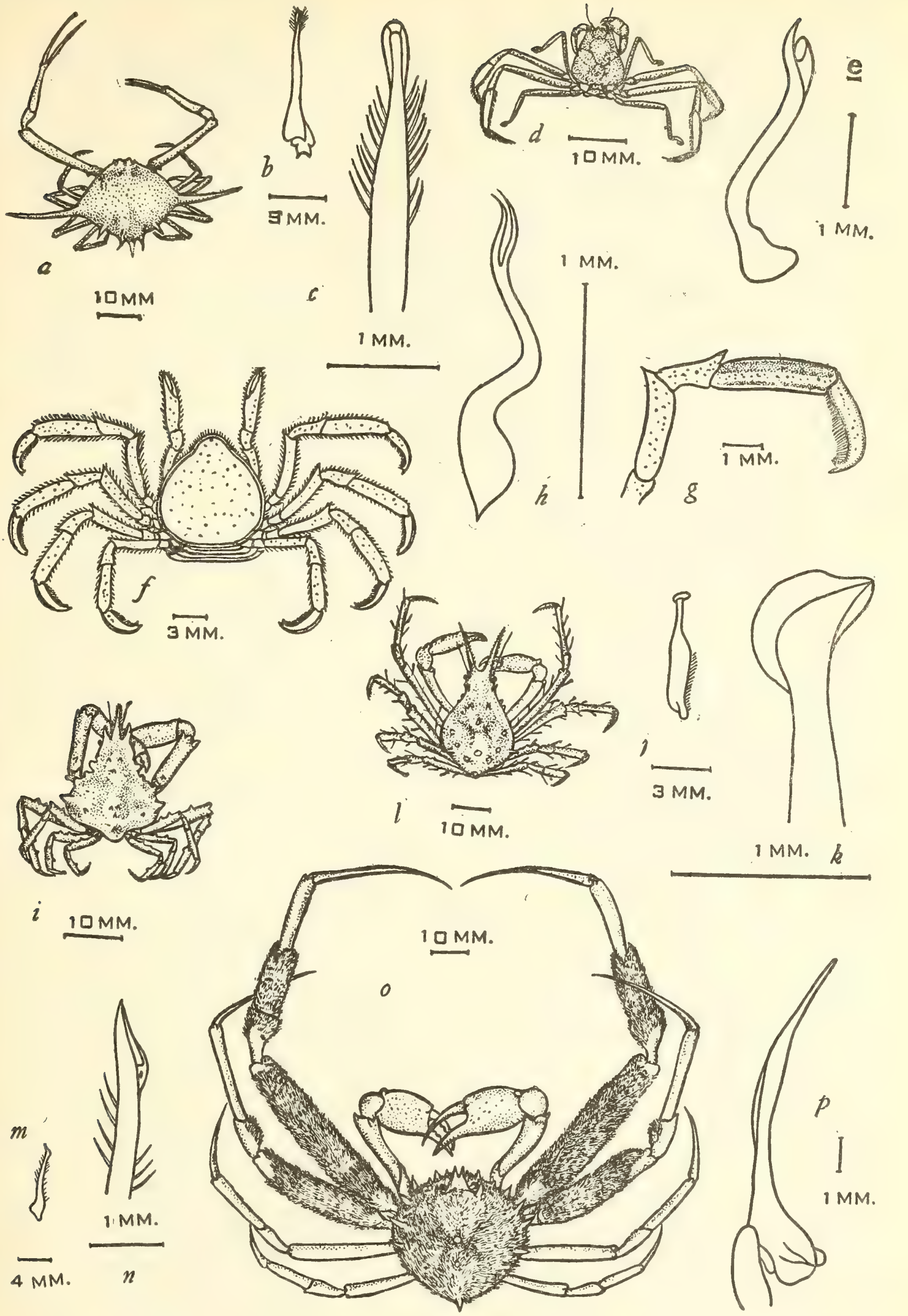
(3) the large size of the spine at the external angle of the buccal frame.

The colour of the carapace and the part of the legs covered by fur is dark green, the last two segments of the legs have a reddish tinge.

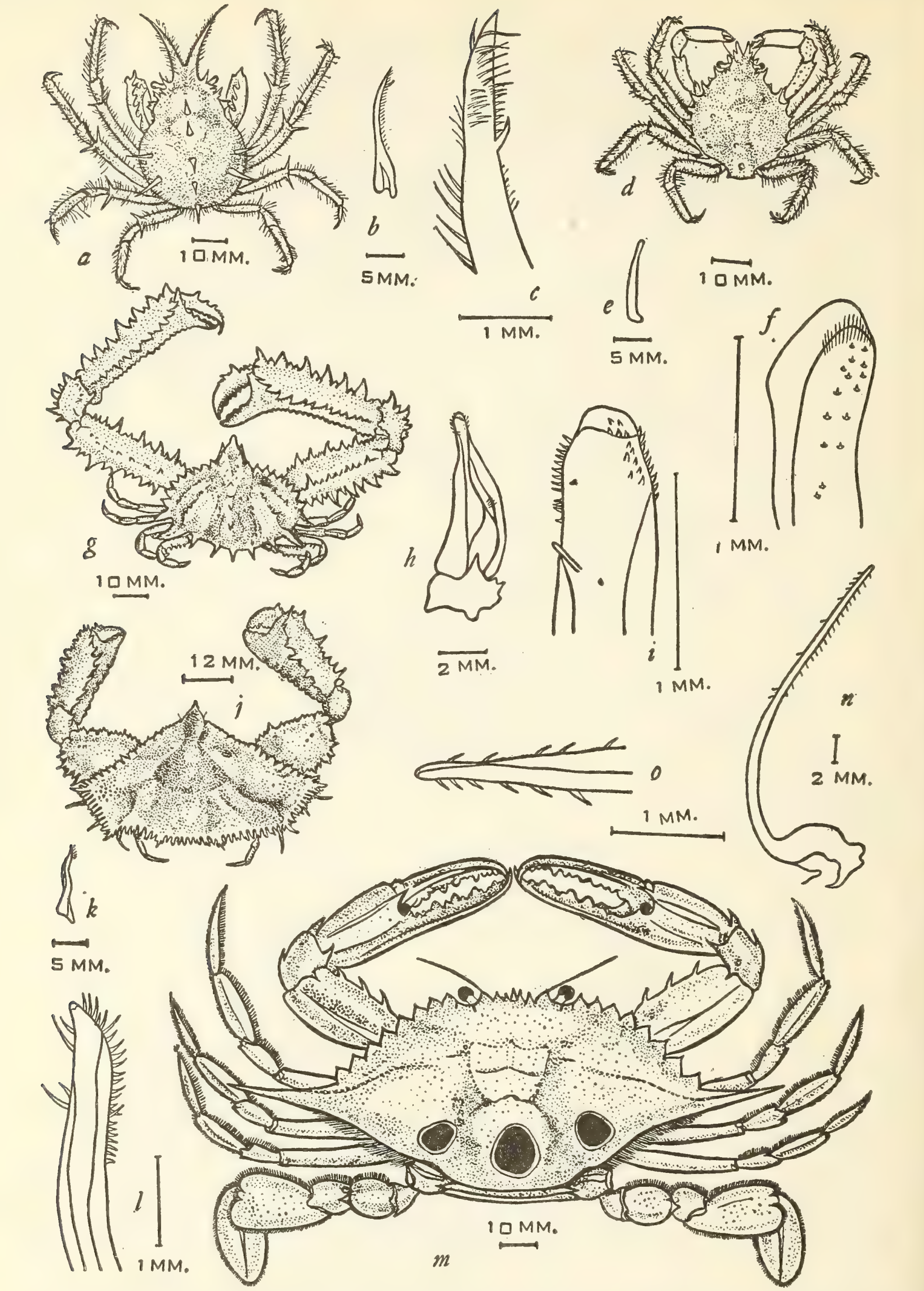
Alcock's description of the species is not complete and can be supplemented by the following observations. The sternum and abdomen are also hairy in the male, except for two knobs on the third abdominal segment. In the female, there is no hair on the abdomen. On the second leg, the proximal half of the propodite is hairy.

The anterior male abdominal appendages are more or less straight, there being only a slight bending about the middle. The distal half of the appendage is abruptly narrowed and the tip is sharply pointed.

This species has been previously recorded from Hong Kong, Mergui Archipelago, Andamans, the Sandheads, Orissa coast, Gulf of Manaar, and Ceylon. This is the first record from the west coast of India.


a
10 MM
b
5 MM.
c
1 MM.
d
10 MM.
e
1 MM.
1 MM.
h
1 MM.
g
f
3 MM.
l
10 MM.
j
3 MM.
1 MM.
k
i
10 MM.
10 MM.
o
m
4 MM.
1 MM.
n
p
1 MM.

a. Arcania septemspinosa (Fabricius). Dorsal view of crab. *b.* 1st left abdominal appendage of male. *c.* Tip of same, enlarged. *d. Dorippe astuta* Fabricius. Dorsal view of crab. *e.* 1st left abdominal appendage of male. *f. Elamena cristatipes* Gravely. Dorsal view of crab. *g.* Walking leg, enlarged. *h.* 1st left abdominal appendage of male. *i. Menaethius monoceros* Latreille. Dorsal view of male. *j.* 1st left abdominal appendage of male. *k.* Tip of same, enlarged. *l. Hyastenus planasius* (Adams & White). Dorsal view of crab. *m.* 1st left abdominal appendage of male. *n.* Tip of same, enlarged. *o. Doclea gracilipes* Stimpson. Dorsal view of male. *p.* 1st left abdominal appendage of male.


a
10 MM.
b
5 MM.
c
1 MM.
d
10 MM.
e
5 MM.
f
1 MM.
g
10 MM.
h
2 MM.
i
1 MM.
j
12 MM.
k
5 MM.
l
1 MM.
m
10 MM.
n
2 MM.
o
1 MM.

a. Paramithrax (*Chlorinoides*) *aculeatus* (Milne-Edwards). Dorsal view of crab. *b.* 1st left abdominal appendage of male. *c.* Tip of same, enlarged. *d. Schizophrys aspera* (Milne-Edwards). Dorsal view of crab. *e.* 1st left abdominal appendage of male. *f.* Tip of same, enlarged. *g. Lambrus* (*Platylambrus*) *prensor* Herbst. Dorsal view of crab. *h.* 1st left abdominal appendage of male. *i.* Tip of same, enlarged. *j. Cryptopodia angulata* Milne-Edwards & Lucas. Dorsal view of crab. *k.* 1st left abdominal appendage of male. *l.* Tip of same, enlarged. *m. Neptunus* (*Neptunus*) *sanguinolentus* (Herbst). Dorsal view of crab. *n.* 1st left abdominal appendage of male. *o.* Tip of same, enlarged.

Subfamily MAIINAE

Genus **Paramithrax** Milne-Edwards

Subgenus **Chlorinoides** Haswell

Paramithrax (Chlorinoides) aculeatus (Milne-Edwards)

(Plate 4)

Mithrax aculeatus, de Saussure and Stimpson, *Crustaces de la Guadeloupe* (1) p. 5 (1867).

Chlorinus aculeatus, var. *armatus*, Miers, '*Alert*' *Crust.*, p. 182 (1884).

Chlorinus aculeatus, Henderson, *Trans. Linn. Soc. London* (*Zool.*) v, p. 345 (1893).

Paramithrax (*Chlorinoides*) *aculeatus*, Alcock, *Journ. As. Soc. Bengal* lxiv, p. 241 (1895).

Calman, *Trans. Linn. Soc. London* (*Zool.*) viii, p. 38 (1900).

Chlorinoides aculeatus, Lanchester, *Proc. Zool. Soc. London*, p. 724 (1900).

Suvatti, *Dept. of Fisheries, Bangkok. Thailand*, p. 150 (1950).

A male and a female specimen from Okha, and a female from Bombay, are in the present collection. It lives among rocks covered with weeds. The measurements of the Okha specimens are given below:—

Male:

length of carapace ...	38 mm.
length of rostrum ...	13 mm

Female:

length of carapace ...	24 mm.
length of rostrum ...	9 mm.

The carapace is pyriform, convex, smooth, armed with five huge thorn-like spines down the middle line, and with two even larger spines on the branchial region. There are also, on either pterygostomian region, two oblique crests, the anterior with three to four teeth, two of which are visible in a dorsal view, and the posterior crest with one or two teeth.

Colour dirty white.

The body and legs in this species are somewhat hairy and are encrusted with sponges, zoophytes, polyzoa, etc. The specimen from Bombay is encrusted with coconut fibres.

The spine on the upper border of the merus is distinct in all the legs, There is another slightly smaller spine at the distal end of the posterior border in all the legs.

In the female from Okha, the first spine on the branchial region is cleft into two from the base. The rostral spines are only a little more than one-third the length of the carapace.

The anterior male abdominal appendage is straight, hairy at the tip, with a hook-like spine near the distal extremity.

This species has been previously recorded from the Arakan coast, Mergui and Ceylon. This is the first record from the west coast of India.

Genus **Schizophrys** White

Schizophrys aspera (Milne-Edwards)

(Plate 4)

Maja (*Dione*) *affinis*, De Haan, *Fauna Japonica* v, p. 94 (1850).
Schizophrys aspera, Haswell, *Catalogue Austr. Crust.*, p. 22 (1882).
de Man, *Journ. Linn. Soc. London* (*Zool.*) xxii, p. 20 (1887).
Walker, *Journ. Linn. Soc. London* (*Zool.*) xx, p. 109 (1890).
Henderson, *Trans. Linn. Soc. London* (*Zool.*) v, p. 346 (1893).
Alcock, *Journ. As. Soc. Bengal* lxiv, p. 243 (1895).
Calman, *Trans. Linn. Soc. London* (*Zool.*) viii, p. 39 (1900).
Lanchester, *Proc. Zool. Soc. London*, p. 725 (1900).
Borradaile, *Fauna Geog. Maldive Laccadive Archipel.* (10) ii, p. 688 (1903).
Laurie, *Ceylon Pearl Oyster Fish. Report* (5), p. 383 (1906).
Gravely, *Bull. Madras Govt. Mus.* i, p. 151 (1927).
Sakai, *Sci. Rep. Tokyo Bun. Daig.* (3) iii, p. 306 (1938).
Tweedie, *Bull. Raffles Mus. Singapore* 18, p. 28 (1947).
Barnard, *Ann. S. Afr. Mus.* xxxviii, p. 61 (1950).
Buitendijk, *Bull. Raffles Mus. Singapore* 21, p. 67 (1950).
Schizophrys asper, Chopra and Das, *Rec. Ind. Mus.* xxxix, p. 390 (1937).

A male and a female from Bombay are in the present collection. It lives in rocky places. The male measures :—

length of carapace	... 31 mm.
breadth of carapace	... 27 mm.
length of rostrum	... 5 mm.
length of cheliped	... 37 mm.
length of hand	... 12 mm.
length of finger	... 6 mm.

It can be distinguished by the pyriform carapace, the greatest breadth of which is nine-tenth its length behind the point of bifurcation of the rostral spines. The outer border of each of the rostral spines carries a strong accessory spine; the length of the rostral spines is from one-fifth to one-sixth that of the carapace. A spine is present ventrally on the subhepatic region outside the angle of the buccal frame.

Colour grey; chelipeds, tubercles, and spines pearly white.

The body and legs are hairy, and the animal protects itself with flat pieces of Nullipore, etc.

In the female an enlarged tubercle exists between the true third and fourth spines of the antero-lateral border at a lower level. There is another tubercle in both the sexes between and above the tubercles marking the posterior border. The anterior male abdominal appendage is straight, blunt at the tip, with a few hairs and minute spines near the tip.

This species is quite common in the Indian coastal waters, being found both from the Bay of Bengal and the Arabian Sea up to Karachi. It has also been recorded from the Red Sea, Persian Gulf, east coast of Africa, Ceylon, Malaya, Australia, New Caledonia, Samoa, and Funafuti. This is the first record from Bombay State.

Family *PARTHENOPIDAE*

Subfamily PARTHENOPINAE

Genus **Lambrus** Leach

Subgenus **Platylambrus** Stimpson

Lambrus (Platylambrus) prensor Herbst

(Plate 4)

Lambrus prensor, Walker, *Journ. Linn. Soc. London* (*Zool.*) xx, p. 109 (1890).
Lambrus (*Platylambrus*) *prensor*, Alcock, *Journ. As. Soc. Bengal* lxiv, p. 262 (1895).
Flipse, *Siboga Exped. Rep.* xxxix, p. 79 (1930).
Chopra, *Rec. Ind. Mus.* xxxvii, p. 473 (1935).

A male was found washed up on the beach at Udvada and another at Bombay. The Udvada specimen measures :—

length of carapace	...	30 mm.
breadth of carapace	...	37 mm.

The carapace is broadly triangular with one median and two lateral carinae. The infra-orbital lobe is entire and strongly produced at the inner angle to form a spine plainly visible from above on either side of the rostrum. The surfaces of the chelipeds are smooth.

Carapace pink, the edges of the fingers of the chelipeds chocolate brown.

The anterior male abdominal appendage is broad, squat, and blunt-tipped ; the tip bears numerous spinules at its extremity.

It is a fairly common species in Indian waters, having been previously recorded from Penang, Andaman Islands, the Arakan coast, the Sandheads, and along the Orissa and Ganjam coasts, Madras, Singapore, Indian Archipelago, and Ceylon. This is the first record from the west coast of India.

Genus **Cryptopodia** Milne-Edwards

Cryptopodia angulata Milne-Edwards & Lucas

(Plate 4)

Cryptopodia angulata, Alcock, *Journ. As. Soc. Bengal* lxiv, p. 282 (1895).
Chopra, *Rec. Ind. Mus.* xxxvii, p. 473 (1935).

A male was caught off the Gulf of Cutch in an otter trawl at a depth of 25 fathoms. It measures :—

length of carapace	...	35 mm.
breadth of carapace	...	59 mm.

This species can be distinguished by the convex, sharply pentagonal carapace, with very large lateral clypeiform vaulted expansions which completely conceal the legs.

Colour pinkish.

The male in the present collection has only five distinct abdominal somites, segments 3–5 being coalesced. The segments, except the terminal, are more or less keeled transversely in the middle, and there is a sharp upright spine on the sixth segment. There are also a few, small scattered tubercles on the composite segment 3–5, on the sixth segment and on the sterna.

The anterior male abdominal appendage is elegantly curved in an S-shape; the tip is pointed and beset with numerous hairs.

This species does not appear to be common in Indian waters, there being only a few specimens from the Sandheads, and perhaps from Orissa. It is, moreover, restricted to Indian waters only. Apart from the Sandheads collection, this species is represented in the Indian Museum collection by a single specimen, collected off Honawar along the west coast of India. This large male has the dorsal surface of the carapace and the chelipeds profusely granular, and their borders far more sharply toothed than is usually the case in this species. It is possible, according to Chopra (1935), that this specimen represents an undescribed species. In that case, the present record is the first from the west coast of India.

Subtribe BRACHYRHYNCHA

Family *PORTUNIDAE*

Subfamily LUPINAE

Genus **Scylla** De Haan

Scylla serrata (Forskal)

(Plate 5)

Scylla serrata, Miers, *Catalogue New Zealand Crust.*, p. 27 (1876).
Haswell, *Catalogue Austr. Crust.*, p. 79 (1882).
Henderson, *Trans. Linn. Soc. London* (*Zool.*) v, p. 372 (1893).
Alcock, *Journ. As. Soc. Bengal* lxviii, p. 27 (1899).
Lanchester, *Proc. Zool. Soc. London*, p. 748 (1900).
Kemp, *Mem. Ind. Mus.* v, p. 248 (1915-1924).
Gravely, *Bull. Madras Govt. Mus.* i, p. 142 (1927).
Shen, *Chin. Journ. Zool.* ii, p. 66 (1936).
Chopra and Das, *Rec. Ind. Mus.* xxxix, p. 391 (1937).
Leene, *Siboga Exped. Rep.* xxxix, p. 14 (1938).
Sakai, *Yokendo Ltd. Tokyo*, p. 384 (1939).
Shen, *Bull. Fan Mem. Inst. Biol.* (*Zool.*) x, p. 81 (1940).
Barnard, *Ann. S. Afr. Mus.* xxxviii, p. 160 (1950).
Suvatti, *Dept. of Fisheries, Bangkok, Thailand*, p. 173 (1950).
Pillai, *Bull. Central Inst. Travancore* ii, p. 21 (1951).

Numerous specimens, of both sexes, from Bombay, Karwar, and Kolak are in the present collection. The largest specimen in the collection, a male, measures:—

length of carapace	... 144 mm.
breadth of carapace	... 211 mm.
length of cheliped	... 345 mm.
girth of hand	... 215 mm.

It can be distinguished by its antero-lateral borders being cut into nine sharply acuminate teeth of about equal size.

Colour a uniformly dark greenish grey.

It is the common edible crab of India which is commercially important, being available in large quantities throughout the year. It is fished along the entire coast of India and the East Indies, especially Java. It reaches a length of eight to nine inches and may weigh two to three pounds.

The anterior male abdominal appendages are elegantly bent and bear hairs along one border and spinules along the other. The tip is shaped like a scalpel and bears a patch of spinules.

It is found all over the Indo-Pacific region, from the Red Sea, east coast of Africa, India, Japan, Australia, Tahiti, and New Zealand.

Genus **Neptunus** De Haan

Subgenus **Neptunus**

Neptunus (Neptunus) sanguinolentus (Herbst)

(Plate 4)

Portunus (*Neptunus*) *sanguinolentus*, De Haan, *Fauna Japonica* v, p. 38 (1850).
Portunus (*Portunus*) *sanguinolentus*, Rathbun, *Dept. of Trade and Customs* (*Fish.*) *of Commonwealth of Australia* v, p. 130 (1923).
Portunus sanguinolentus, Suvatti, *Dept. of Fisheries, Bangkok, Thailand*; p. 172 (1950).
Neptunus sanguinolentus, Miers, *Catalogue New Zealand Crust.*, p. 26 (1876).
Haswell, *Catalogue Austr. Crust.*, p. 77 (1882).
Henderson, *Trans. Linn. Soc. London* (*Zool.*) v, p. 368 (1893).
Alcock and Anderson, *Journ. As. Soc. Bengal* lxiii, p. 201 (1894).
Alcock, *Journ. As. Soc. Bengal* lxviii, p. 32 (1899).
Calman, *Trans. Linn. Soc. London* (*Zool.*) viii, p. 21 (1900).
Kohli, *Proc. Lahore Phil. Soc.* iii, p. 84 (1921–1922).
Delsman and de Man, *Treubia* vi, p. 310 (1925).
Pillai, *Bull. Central Inst. Travancore* ii, p. 21 (1951).
Neptunus (*Neptunus*) *sanguinolentus*, Lanchester, *Proc. Zool. Soc. London*, p. 745 (1900).
Laurie, *Ceylon Pearl Oyster Fish. Report* (5), p. 412 (1906).
Chopra, *Rec. Ind. Mus.* xxxvii, p. 474 (1935).
Chopra and Das, *Rec. Ind. Mus.* xxxix, p. 391 (1937).
Sakai, *Yokendo Ltd. Tokyo*, p. 387 (1939).
Shen, *Bull. Fan Mem. Inst. Biol.* (*Zool.*) x, p. 81 (1940).
Lupa sanguinolenta, Barnard, *Ann. S. Afr. Mus.* xxxviii, p. 154 (1950).

Numerous specimens, of both sexes, were caught in Bombay and Karwar. An average male measures :—

length of carapace	... 43 mm.
breadth of carapace (excluding the last lateral spines)	... 76 mm.
length of cheliped	... 94 mm.

The antero-lateral borders are cut into nine teeth, of which the last is the largest. There is no spine on the posterior border of the arm of the chelipeds.

Colour dark grey, three blood-red spots ringed with white posteriorly.

The anterior male abdominal appendages are quite straight and have no sharp bend near the tip. The margins in the distal part are beset with somewhat stout spines.

This species has been previously recorded from Hong Kong, the Andamans, India, Ceylon, Persian Gulf, Red Sea (coast of Eritrea), Natal, Cape of Good Hope, Indian Archipelago, China Sea, Japan, Hawaii, and Australia.

Neptunus (Neptunus) pelagicus (Linnaeus)

(Plate 6)

Portunus (*Neptunus*) *pelagicus*, De Haan, *Fauna Japonica* v, p. 37 (1850).
Portunus (*Portunus*) *pelagicus*, Rathbun, *Dept. of Trade and Customs* (*Fish.*) *of Commonwealth of Australia* v, p. 130 (1923).
Portunus pelagicus, Montgomery, *Journ. Linn. Soc. London* (*Zool.*) xxxvii, p. 427 (1931).
Suvatti, *Dept. of Fisheries, Bangkok, Thailand*, p. 171 (1950).
Neptunus pelagicus, Miers, *Catalogue New Zealand Crust.*, p. 25 (1876).
Haswell, *Catalogue Austr. Crust.*, p. 77 (1882).
Walker, *Journ. Linn. Soc. London* (*Zool.*) xx, p. 110 (1890).
Henderson, *Trans. Linn. Soc. London* (*Zool.*) v, p. 367 (1893).
Alcock, *Journ. As. Soc. Bengal* lxviii, p. 34 (1899).
Calman, *Trans. Linn. Soc. London* (*Zool.*) viii, p. 21 (1900).
Kohli, *Proc. Lahore Phil. Soc.* iii, p. 85 (1921–1922).
Delsman and de Man, *Treubia* vi, p. 309 (1925).
Gravely, *Bull. Madras Govt. Mus.* i, p. 142 (1927).
Pillai, *Bull. Central Inst. Travancore* ii, p. 21 (1951).
Neptunus (*Neptunus*) *pelagicus*, Lanchester, *Proc. Zool. Soc. London*, p. 745 (1900).
Laurie, *Ceylon Pearl Oyster Fish. Report* (5), p. 412 (1906).
Chopra, *Rec. Ind. Mus.* xxxvii, p. 476 (1935).
Sakai, *Yokendo Ltd. Tokyo*, p. 387 (1939).
Shen, *Bull. Fan Mem. Inst. Biol.* (*Zool.*) x, p. 81 (1940).
Lupa pelagica, Barnard, *Ann. S. Afr. Mus.* xxxviii, p. 153 (1950).

Numerous specimens, of both sexes, from Bombay, Karwar, and Okha are in the present collection. An average male measures :—

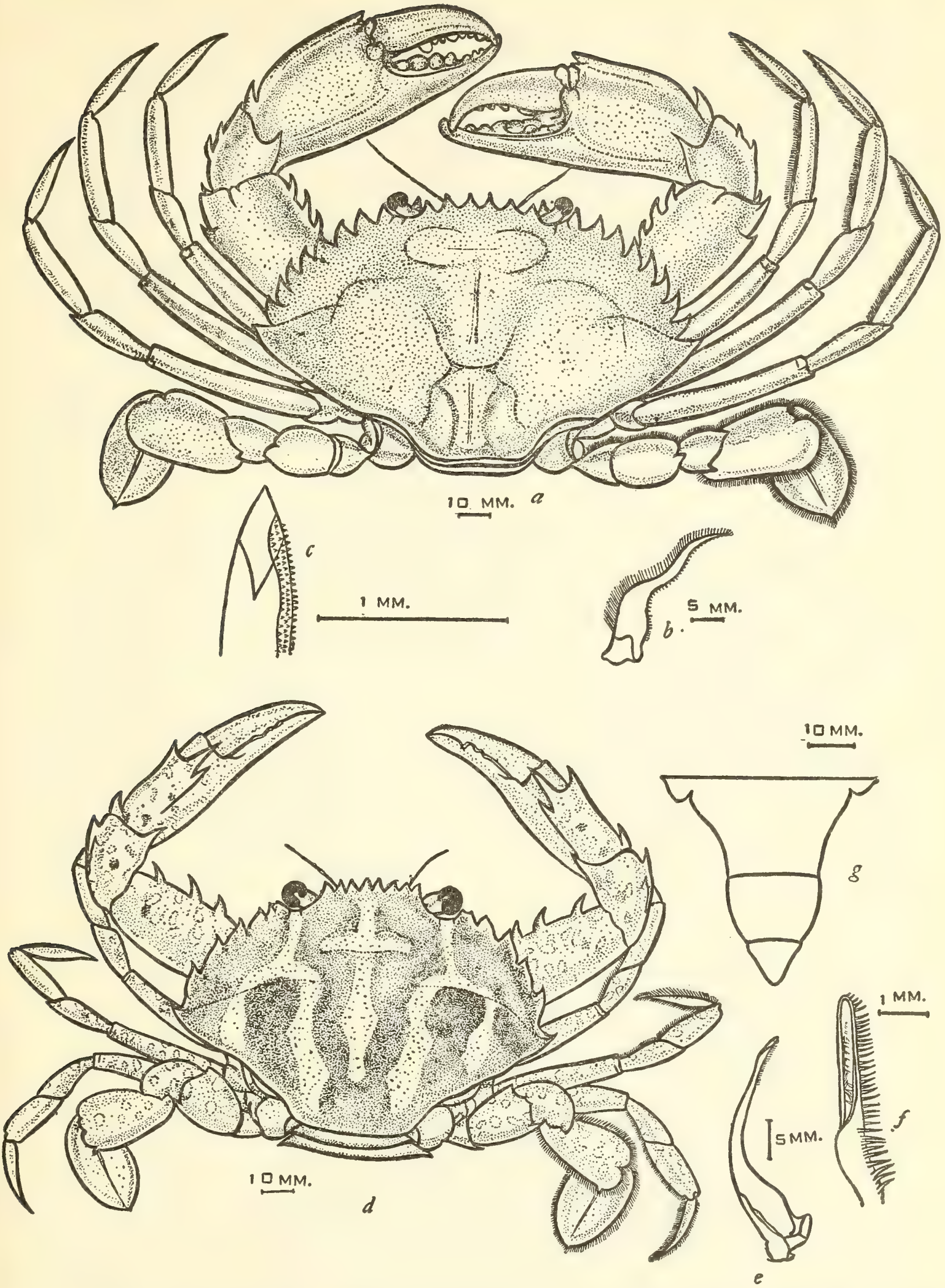
length of carapace	... 57 mm.
breadth of carapace	... 167 mm.

This species is distinguished from *Neptunus* (*Neptunus*) *sanguinolentus* by the presence of a spine at the far end of the posterior border of the arm of the chelipeds.

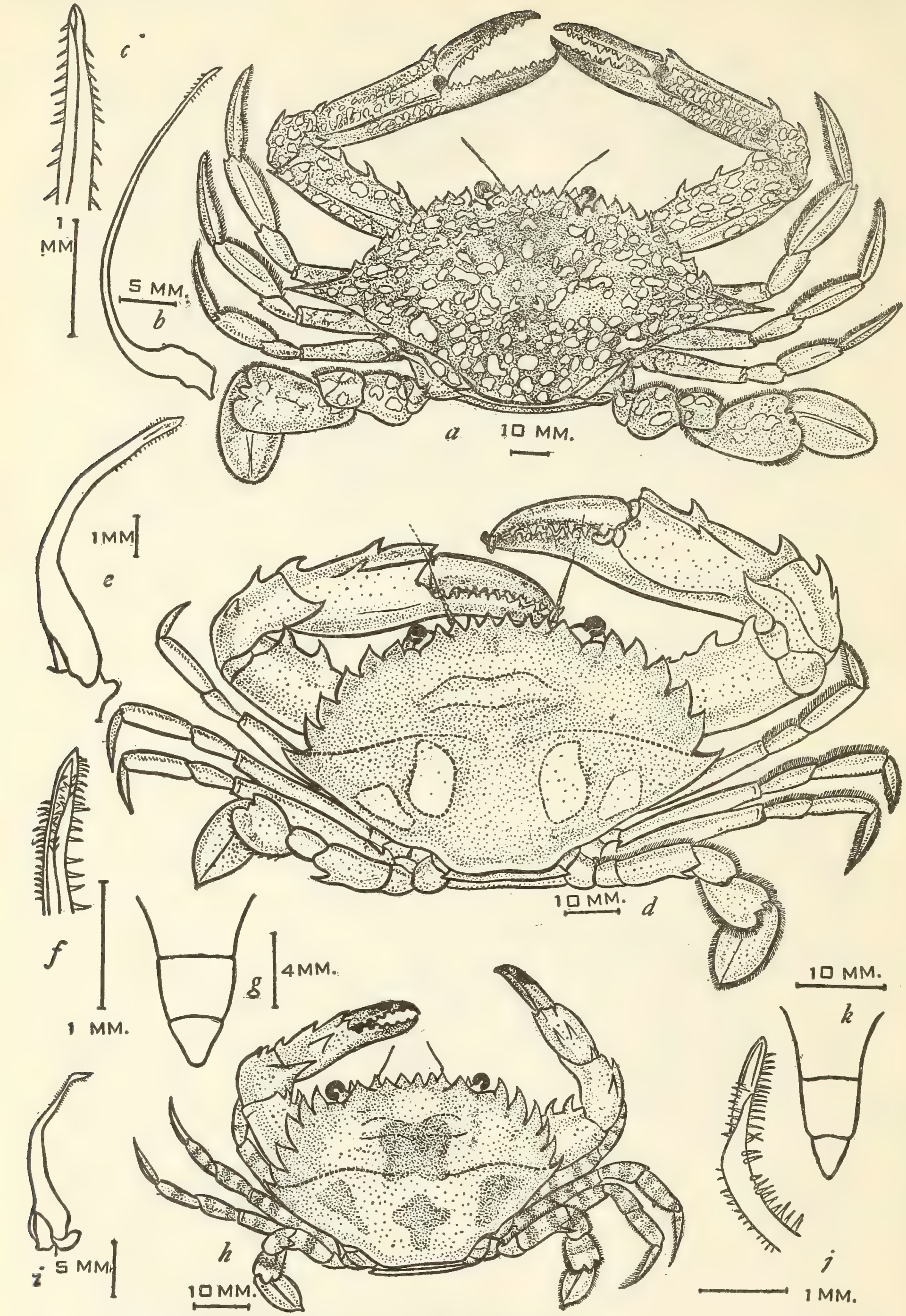
Colour in the male, pinkish purple, with extensive irregular white spots, the tips of the chelae and the distal segments of the legs purple; female sand-coloured.

Like *Scylla serrata*, this species is also of economic importance, as it is available in large numbers and grows to four or five inches across the carapace.

The anterior male abdominal appendages are quite straight and have no sharp bend near the tip. The margins in the distal part are beset


10 MM.
a
c
1 MM.
5 MM.
b
10 MM.
g
1 MM.
5 MM.
f
10 MM.
d
e

a. Scylla serrata (Forskal). Dorsal view of crab. *b.* 1st left abdominal appendage of male. *c.* Tip of same, enlarged. *d. Charybdis* (*Goniosoma*) *cruciata* (Herbst). Dorsal view of crab (walking legs on left side denuded of hair). *e.* 1st left abdominal appendage of male. *f.* Tip of same, enlarged. *g.* Male abdomen.


c
1 MM
5 MM
b
a
10 MM.
1MM
e
10 MM.
d
f
1 MM.
g
4MM.
10 MM.
k
i
5 MM
h
10MM.
j
1 MM.

a. Neptunus (Neptunus) pelagicus (Linnaeus). Dorsal view of crab. *b.* 1st left abdominal appendage of male. *c.* Tip of same, enlarged. *d. Charybdis (Goniosoma) lucifera* (Fabricius). Dorsal view of crab (walking legs on left side denuded of hair). *e.* 1st left abdominal appendage of male. *f.* Tip of same, enlarged. *g.* Male abdomen. *h. Charybdis (Goniosoma) annulata* (Fabricius). Dorsal view of crab (walking legs on left side denuded of hair). *i.* 1st left abdominal appendage of male. *j.* Tip of same, enlarged. *k.* Male abdomen.

with a larger number of spines than in *Neptunus* (*Neptunus*) *sanguinolentus.*

It has been previously recorded from the Red Sea (Suez), Mediterranean (Port Said), Natal, Zanzibar, Mozambique, Madagascar, India, Persian Gulf, Mergui Archipelago, Ceylon, Singapore, Indian Archipelago, Philippines, Australia, New Zealand, New Caledonia, Tahiti, China Sea, and Japan.

Genus **Charybdis** De Haan

Subgenus **Goniosoma** Milne-Edwards

Charybdis (Goniosoma) cruciata (Herbst)

(Plate 5)

Portunus (*Oceanus*) *crucifer*, De Haan, *Fauna Japonica* v, p. 40 (1850).
Goniosoma cruciferum, de Man, *Journ. Linn. Soc. London* (*Zool.*) xxii, p. 79 (1887).
Henderson, *Trans. Linn. Soc. London* (*Zool.*) v, p. 374 (1893).
Goniosoma crucifera, Walker, *Journ. Linn. Soc. London* (*Zool.*) xx, p. 110 (1890).
Charybdis (*Goniosoma*) *crucifera*, Alcock, *Journ. As. Soc. Bengal* lxviii, p. 51 (1899).
Pillai, *Bull. Central Inst. Travancore* ii, p. 22 (1951).
Charybdis (*Goniosoma*) *cruciata*, Delsman and de Man, *Treubia* vi, p. 311 (1925).
Chopra and Das, *Rec. Ind. Mus.* xxxix, p. 392 (1937).
Leene, *Siboga Exped. Rep.* xxxix, p. 24 (1938).
Shen, *Bull. Fan Mem. Inst. Biol.* (*Zool.*) x, p. 82 (1940).
Charybdis (*Goniosoma*) *cruciatus*, Chopra, *Rec. Ind. Mus.* xxxvii, p. 482 (1935).
Charybdis cruciata, Sakai, *Yokendo Ltd. Tokyo* p. 403 (1939).
Barnard, *Ann. S. Afr. Mus.* xxxviii, p. 166 (1950).
Suvatti, *Dept. of Fisheries, Bangkok, Thailand*, p. 175 (1950).

Numerous specimens, of both sexes, were caught at Bombay and off the Gulf of Cutch at a depth of 25 fathoms. A large male measures:—

length of carapace	... 83 mm.
breadth of carapace	... 133 mm.
length of cheliped	... 260 mm.
distance between the tips of outstretched chelipeds	... 560 mm.

There are no distinct transverse ridges behind the level of the last spine of the antero-lateral borders. The first spine of this border is anteriorly truncated. The major diameter of the orbits is one-third the width of the inter-orbital space. The propodite of the last pair of legs bears one or two inconspicuous denticles near the far end of its posterior border. In the male abdomen the sixth segment is much broader than long and has curved and gently convergent sides.

Colour purplish brown with a large yellow cross; chelipeds purple, spotted with yellow, the tips pink and light brown.

The anterior male abdominal appendages are more or less straight, with the tip bluntly pointed. There is a thick fringe of hairs on the distal part of the outer margin, and a few short scattered hairs on the upper surface also.

It is a very common Indian species, occurring extensively both in the Bay of Bengal and the Arabian Sea. It is also found in the Indian Ocean, South Africa, Indian Archipelago, China Sea, Japan, and Australia.

Its large size makes it a suitable edible species, but it is not very common along the Bombay coast.

Charybdis (Goniosoma) lucifera (Fabricius)

(Plate 6)

Portunus (*Oceanus*) *dentatus*, de Haan, *Fauna Japonica* v, p. 41 (1850).
Goniosoma luciferum, Henderson, *Trans. Linn. Soc. London* (*Zool.*) v, p. 374 (1893).
Alcock and Anderson, *Journ. As. Soc. Bengal* lxiii, p. 201 (1894).
Charybdis (*Goniosoma*) *quadrimaculata*, Alcock, *Journ. As. Soc. Bengal* lxviii, p. 54 (1899).
Charybdis (*Goniosoma*) *lucifera*, Delsman and de Man, *Treubia* vi, p. 313 (1925).
Chopra and Das, *Rec. Ind. Mus.* xxxix, p. 392 (1937).
Charybdis (*Charybdis*) *luciferae*, Leene, *Siboga Exped. Rep.* xxxix, p. 57 (1938).
Charybdis lucifer, Sakai, *Yokendo Ltd. Tokyo*, p. 401 (1939).
Suvatti, *Dept. of Fisheries, Bangkok, Thailand*, p. 175 (1950).

The present collection is represented by a male from Bombay. It measures :—

length of carapace	...	51 mm.
breadth of carapace	...	82 mm.
length of cheliped	...	132 mm.

A sharply dentiform lobule at the outer end of the lower border of the orbit is characteristic of this species.

Colour yellowish brown with two large white spots on either branchial region, chelipeds scarlet pink, the tips light brown, extreme tips whitish.

The posterior border of the propodite of the last pair of legs is serrated throughout. The sixth male abdominal segment has its sides parallel or even slightly divergent in at least two-thirds of its extent.

In the anterior male abdominal appendages, there is no bend near the tip. The inner margin in its distal part is beset with hairs. There is a fringe of hairs on the distal part of the outer margin also.

This species is met with on both coasts of India, Ceylon, Java, and Siam.

Charybdis (Goniosoma) annulata (Fabricius)

(Plate 6)

Goniosoma annulatum, Henderson, *Trans. Linn. Soc. London* (*Zool.*) v, p. 375 (1893).
Charybdis (*Goniosoma*) *annulata*, Alcock, *Journ. As. Soc. Bengal* lxviii, p. 54 (1899).
Gravely, *Bull. Madras Govt. Mus.* i, p. 142 (1927).
Chopra and Das, *Rec. Ind. Mus.* xxxix, p. 393 (1937).
Leene, *Siboga Exped. Rep.* xxxix, p. 60 (1938).
Pillai, *Bull. Central Inst. Travancore* ii, p. 22 (1951).

Charybdis annulata, Sakai, *Yokendo Ltd. Tokyo* p. 402 (1939).
Barnard, *Ann. Mag. nat. hist.* xiii, p. 363 (1946).
Barnard, *Ann. S. Afr. Mus.* xxxviii, p. 169 (1950).
Suvatti, *Dept. of Fisheries, Bangkok, Thailand,* p. 175 (1950).

Numerous specimens, of both sexes, were caught at Bombay. An average male measures :—

length of carapace	... 39 mm.
breadth of carapace	... 56 mm.
diameter of orbit	... 7 mm.
inter-orbital space	... 20 mm.

The following may be added to Alcock's description. The upper borders of the merus, carpus, propodus, and dactylus, and the lower borders of the propodus and dactylus of the legs are fringed with hairs.

The posterior border of the propodites of the last pair of legs is serrated in a large part of its extent.

The sixth male abdominal segment is nearly as long as broad and has its sides parallel for about three-fourth of their extent.

In the specimens in the present collection, there is no spinule at the far end of the inferior border of the arm of the chelipeds. Moreover, the major diameter of the orbits is one-third the width of the inter-orbital space.

The anterior male abdominal appendages are somewhat sharply bent near the tip. The inner margin has a small lobe-like process a little behind the tip.

Colour flesh-coloured or purple with creamy blotches, with a light greenish tinge. Legs and chelipeds with circular purple and creamy bands, fingers deep red, grey, and black, with brownish white tips. Other specimens have a uniform sandy brown colour.

This species has been previously recorded from Penang, Bimlipatam, Travancore, Karachi, Tahiti, Siam, Mergui, and Ceylon.

Charybdis (Goniosoma) callianassa (Herbst)

(Plate 7)

Goniosoma variegatum, var. *callianassa,* Henderson, *Trans. Linn. Soc. London (Zool.)* v, p. 377 (1893).
Alcock and Anderson, *Journ. As. Soc. Bengal* lxiii, p. 201 (1894).
Charybdis (Goniosoma) callianassa, Alcock, *Journ. As. Soc. Bengal* lxviii, p. 57 (1899).
Chopra, *Rec. Ind. Mus.* xxxviii, p. 489 (1935).
Chopra and Das, *Rec. Ind. Mus.* xxxix, p. 395 (1937).
Shen, *Bull. Fan Mem. Inst. Biol. (Zool.)* x, p. 83 (1940).
Charybdis (Charybdis) callianassa, Leene, *Siboga Exped. Rep.* xxxix, p. 81 (1938).
Charybdis callianassa, Suvatti, *Dept. of Fisheries, Bangkok, Thailand,* p. 175 (1950).

Numerous specimens, of both sexes, from Bombay and Udvada are in the present collection. Average specimens measure :—

Male :—

length of carapace	... 15 mm.
breadth of carapace	... 24 mm.

Female :—

length of carapace	... 14 mm.
breadth of carapace	... 25 mm.

The carapace in this species is convex, about two-third as long as broad (except in adult females, in which the last spine of the antero-lateral borders is prolonged). The teeth on the antero-lateral borders are serrulate. A transverse ridge is present on the cardiac region. The posterior border of the propodites of the last pair of legs is smooth. The sixth male abdominal segment is transversely oblong with the anterior angles rounded.

Colour dirty white or light grey.

In the specimens in the present collection, the ridge on the cardiac region is present, as also the carina on the fourth abdominal tergum of the female. The major diameter of the orbit is a little less than one third the inter-orbital space.

The anterior male abdominal appendages are sharply bent a little way behind the tip, which is somewhat sharply pointed. There are only a few hairs on the outer border quite close to the tip.

This species has been previously recorded from the east coast of India, Bombay, Karachi, Siam, and Sumatra.

Charybdis (Goniosoma) orientalis (Dana)

(Plate 7)

Goniosoma orientale, Henderson *Trans. Linn. Soc. London* (*Zool.*) v, p. 375 (1893).
Charybdis (*Goniosoma*) *orientalis*, Alcock, *Journ. As. Soc. Bengal* lxviii, p. 63 (1899).
Laurie, *Ceylon Pearl Oyster Fish. Report* (5), p. 418 (1906).
Charybdis (*Charybdis*) *orientalis*, Leene, *Siboga Exped. Rep.* xxxix, p. 68 (1938).
Charybdis orientalis, Sakai, *Yokendo Ltd. Tokyo*, p. 407 (1939).
Barnard, *Ann. S. Afr. Mus.* xxxviii, p. 170 (1950).

The present collection is represented by numerous specimens, of both sexes, from Bombay. An average male measures :—

length of carapace	... 29 mm.
breadth of carapace	... 46 mm.

This species is distinguished by the presence of one ridge on the posterior half of each branchial region, and the rudimentary nature of the second tooth on the antero-lateral borders. The posterior border of the propodite of the last pair of legs is serrated. The sixth male abdominal segment is almost square with the anterior angles rounded.

Colour of carapace mottled gray brown, spines tipped brown, fingers of chelipeds dark red, tips brownish, extreme tips white, alternate dark and light grey-brown stripes on legs.

In the specimens in the present collection, there is no trace of any ridge behind the level of the last spines of the antero-lateral borders.

The anterior male abdominal appendage is bent a little way from the tip, which is slender; the inner margin is notched off in a small rounded lobule a little way behind the tip. Both the borders bear hairs, the outer border up to the tip.

This species has been previously recorded from Pedro Shoal, Madras, and Arakan coasts. This is the first record from the west coast of India.

Subgenus **Goniohellenus**

Charybdis (Goniohellenus) hoplites (Wood-Mason)

(Plate 7)

Charybdis (*Goniohellenus*) *hoplites*, Alcock, *Journ. As. Soc. Bengal* lxviii, p. 66 (1899).
Leene, *Siboga Exped. Rep.* xxxix, p. 99 (1938).
Charybdis hoplites, Rathbun, *Trans. Linn. Soc. London* (*Zool.*) (II) xiv, p. 207 (1911).

A male, with both the chelipeds broken off, was caught off the Gulf of Cutch at a depth of 25 fathoms. It measures :—

length of carapace	...	27 mm.
breadth of carapace	...	55 mm.

In this species the antennal flagellum is completely excluded from the orbital hiatus, and the posterior border of the carapace forms an angular junction with the postero-lateral borders. The posterior border of the arm of the chelipeds ends in a spine. The last tooth of the antero-lateral borders is a long, *Neptunus*-like spine at least twice as long as those in front of it.

Colour dirty white.

The posterior border of the propodite of the last pair of legs is finely serrated. The sixth male abdominal segment is truncate-triangular, having almost no curve to the sides.

In the specimen in the present collection, the two granular subregional convexities of the anterior part of the gastric region are distinct ridges. There is a terminal spinule on the posterior border of the merus of the penultimate pair of legs. The lower orbital border outside the inner angle is finely crenulate.

The anterior male abdominal appendages are extremely broad at the base. The tip is spoon-like and bears hairs along both borders.

This species has been previously recorded from the Coromandel coast, and off the Indus delta. This is the first record from Bombay State.

Genus **Thalamita** Milne-Edwards

Thalamita crenata Milne-Edwards

(Plate 7)

Thalamita crenata, de Man, *Journ. Linn. Soc. London* (*Zool.*) xxii, p. 79 (1887).
Alcock, *Journ. As. Soc. Bengal* lxviii, p. 76 (1899).
Lanchester, *Proc. Zool. Soc. London*, p. 748 (1900).
Rathbun, *Trans. Linn. Soc. London* (*Zool.*) (11) xiv, p. 207 (1911).
Kemp, *Mem. Ind. Mus.* v, p. 249 (1915-1924).
Kohli, *Proc. Lahore Phil. Soc.* iii, p. 85 (1921-1922).
Delsman and de Man, *Treubia* vi, p. 313 (1925).
Gravely, *Bull. Madras Govt. Mus.* i, p. 144 (1927).
Sakai, *Yokendo Ltd. Tokyo*, p. 414 (1939).
Shen, *Bull. Fan Mem. Inst. Biol.* (*Zool.*) x, p. 84 (1940).
Barnard, *Ann. S. Afr. Mus.* xxxviii, p. 172 (1950).
Suvatti, *Dept. of Fisheries, Bangkok, Thailand*, p. 174 (1950).
Tweedie, *Bull. Raffles Mus. Singapore* 21, p. 109 (1950).
Thalamita prymna var. *crenata*, Laurie, *Ceylon Pearl Oyster Fish. Report* (5), p. 418 (1906).

Numerous specimens, of both sexes, from Bombay represent the present collection. An average male measures :—

length of carapace	... 34 mm.
breadth of carapace	... 51 mm.

The antero-lateral borders of the carapace are cut into five equal teeth. The transverse ridges of the carapace are faint. The front is cut into six lobes, exclusive of the inner supra-orbital angles. The extreme extent of the basal antennal joint is far greater than the major diameter of the orbit. The outer surfaces of the palms of the chelipeds are nearly smooth. The posterior border of the propodite of the last pair of legs sometimes has two to three denticles, but these are often absent. The sixth male abdominal segment is broader than long and has gently curved sides.

Colour uniform greenish grey, claws pinkish, tips dark brown, extreme tips white.

The anterior male abdominal appendages are straight, the tip bearing a few hairs.

This species has been previously recorded from the Andamans, Mergui, Bombay, Karachi, Red Sea, east coast of Africa, Persian Gulf, Singapore, Japan, Australia, New Zealand, and Samoa.

According to the opinion of the International Commission on Zoological Nomenclature (Prov. Biol. Soc., Washington, xxxi+x, 1926, p. 91) Milne-Edwards, not Latreille, must be regarded as the author of this species, as Latreille did not publish the name ; the latter is, according to Milne-Edwards, that of a specimen in the Paris Museum.

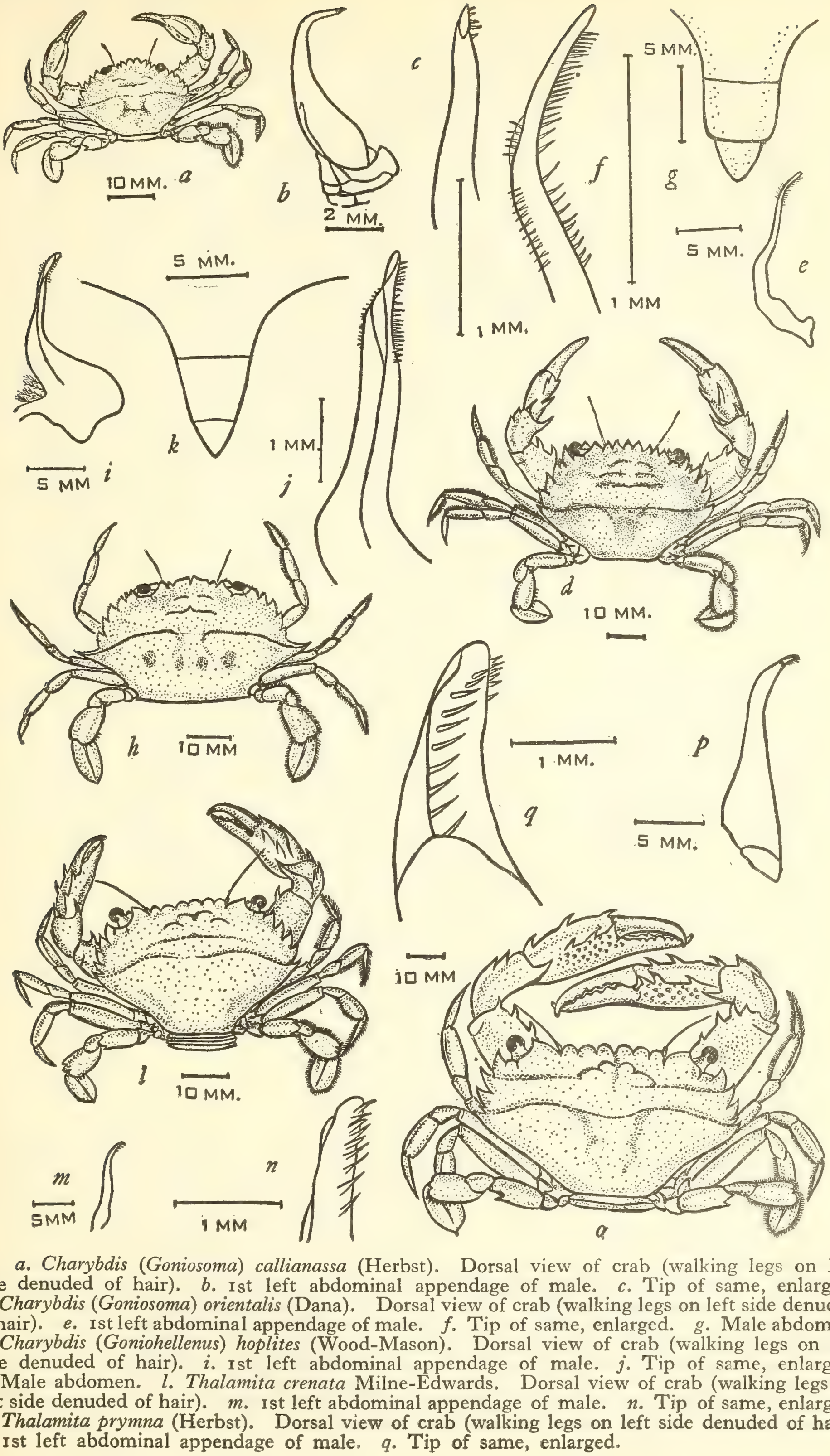
Thalamita prymna (Herbst)

(Plate 7)

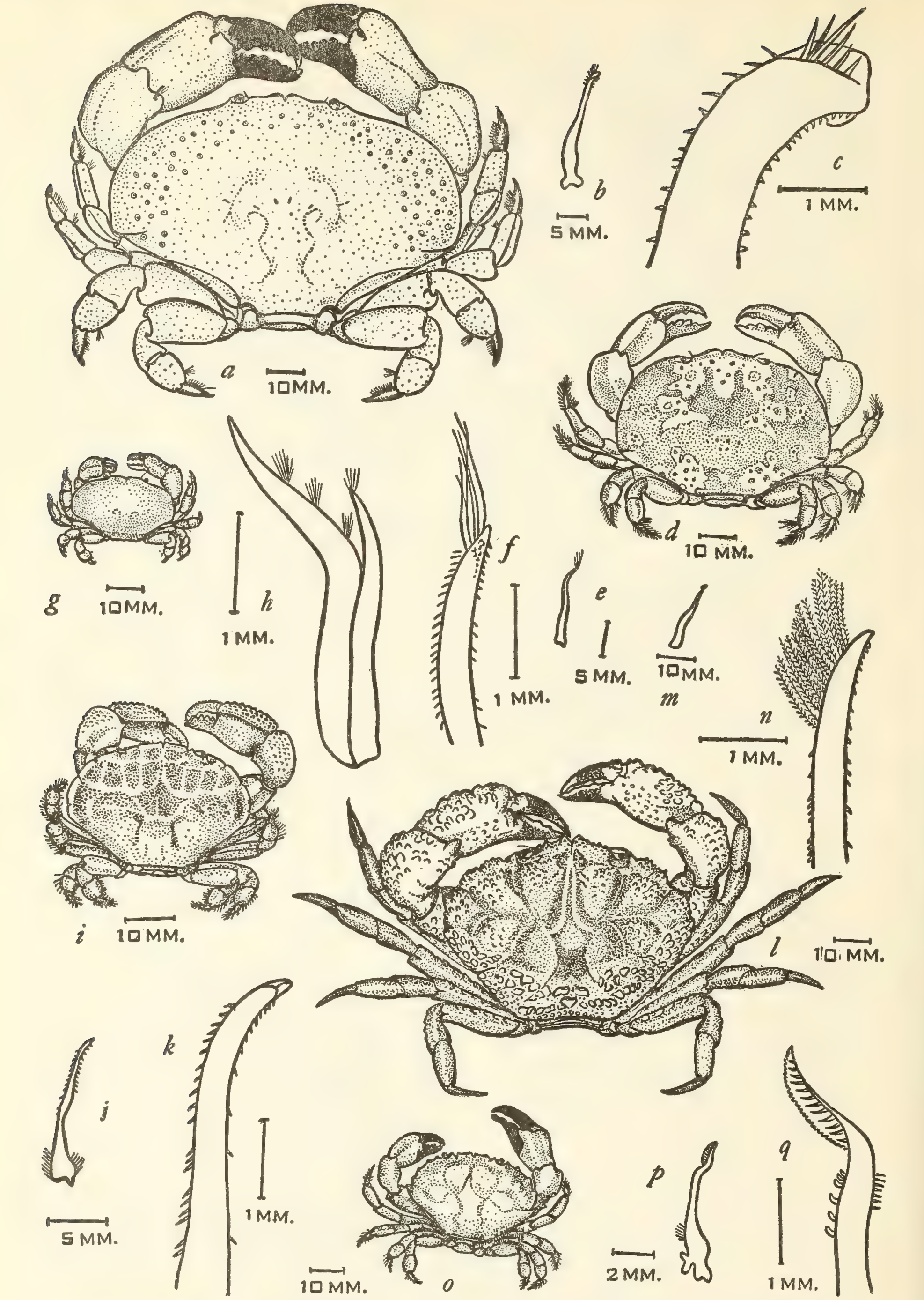
Portunus (*Thalamita*) *prymna*, De Haan, *Fauna Japonica* v, p. 43 (1850).
Thalamita prymna, Haswell, *Catalogue Austr. Crust.*, p. 80 (1882).
 de Man, *Journ. Linn. Soc. London* (*Zool.*) xxii, p. 75 (1887).
 Henderson, *Trans. Linn. Soc. London* (*Zool.*) v, p. 372 (1893).
 Alcock and Anderson, *Journ. As. Soc. Bengal* lxiii, p. 201 (1894).
 Alcock, *Journ. As. Soc. Bengal* lxviii, p. 78 (1899).
 Calman, *Trans. Linn. Soc. London* (*Zool.*) viii, p. 22 (1900).
 Borradaile, *Fauna Geog. Maldive Laccadive Archipel.* (2) i, p. 201 (1902).
 Rathbun, *Trans. Linn. Soc. London* (*Zool.*) (II) xiv, p. 208 (1911).
 Gravely, *Bull, Madras Govt. Mus.* i, p. 144 (1927).
 Chopra and Das, *Rec. Ind. Mus.* xxxix, p. 395 (1937).
 Sakai, *Yokendo Ltd. Tokyo*, p. 416 (1939).
 Barnard, *Ann. S. Afr. Mus.* xxxviii, p. 84 (1950).
 Suvatti, *Dept. of Fisheries, Bangkok, Thailand*, p. 174 (1950).
 Tweedie, *Bull. Raffles Mus. Singapore* 21, p. 81 (1950).

A male and a female from Okha are in the present collection. The male measures :—

length of carapace	... 32 mm.
breadth of carapace	... 65 mm.



a. Charybdis (*Goniosoma*) *callianassa* (Herbst). Dorsal view of crab (walking legs on left side denuded of hair). *b.* 1st left abdominal appendage of male. *c.* Tip of same, enlarged. *d. Charybdis* (*Goniosoma*) *orientalis* (Dana). Dorsal view of crab (walking legs on left side denuded of hair). *e.* 1st left abdominal appendage of male. *f.* Tip of same, enlarged. *g.* Male abdomen. *h. Charybdis* (*Goniohellenus*) *hoplites* (Wood-Mason). Dorsal view of crab (walking legs on left side denuded of hair). *i.* 1st left abdominal appendage of male. *j.* Tip of same, enlarged. *k.* Male abdomen. *l. Thalamita crenata* Milne-Edwards. Dorsal view of crab (walking legs on left side denuded of hair). *m.* 1st left abdominal appendage of male. *n.* Tip of same, enlarged. *o. Thalamita prymna* (Herbst). Dorsal view of crab (walking legs on left side denuded of hair). *p.* 1st left abdominal appendage of male. *q.* Tip of same, enlarged.


a
10MM.
b
5 MM.
c
1 MM.
d
10 MM.
g
10MM.
h
1MM.
f
1 MM.
e
5 MM.
10MM.
m
n
1 MM.
i
10MM.
l
10 MM.
j
5 MM.
k
1MM.
10 MM.
o
p
2 MM.
q
1 MM.

a. Atergatis integerrimus (Lamarck). Dorsal view of crab. *b.* 1st left abdominal appendage of male. *c.* Tip of same, enlarged. *d. Atergatis floridus* (Rumph). Dorsal view of crab. *e.* 1st left abdominal appendage of male. *f.* Tip of same, enlarged. *g. Atergatis roseus* (Ruppell). Dorsal view of crab. *h.* 1st left abdominal appendage of male. *i. Platypodia cristata* (Milne-Edwards). Dorsal view of crab. *j.* 1st left abdominal appendage of male. *k.* Tip of same, enlarged. *l. Xantho* (*Lophoxanthus*) *scaberrimus baccalipes* Alcock. Dorsal view of crab. *m.* 1st left abdominal appendage of male. *n.* Tip of same, enlarged. *o. Leptodius exaratus* (Milne-Edwards). Dorsal view of crab. *p.* 1st left abdominal appendage of male. *q.* Tip of same, enlarged.

This species is distinguished by the fourth tooth of the antero-lateral borders being rudimentary, and sometimes even absent. The orbital prolongation of the basal antennal joint is traversed by a row of spines of which from one to three are large. The posterior border of the propodite of the last pair of legs is serrated throughout. The sixth male abdominal segment is about as long as broad, and has gently convergent sides.

In the female specimen in the present collection, there are six spines on the hand of the chelipeds instead of five, and four on the arm (one very small spine distally).

The anterior male abdominal appendages are bent towards the tip which is spoon-like and bears a few hairs.

This species has been previously recorded from the Bay of Bengal from Mergui to Madras, Natal, Red Sea, Andamans, Malayan Archipelago, Liu-Kiu Island, Japan, Australia, New Caledonia, Tonga Islands and Samoa. This is the first record from the west coast of India.

It has become customary to refer to 'prymna' all forms of *Thalamita* in which the front is cut into eight lobes, the basal antennal joint exceeds in breadth the diameter of the orbit and bears a row of spines, and the fourth antero-lateral tooth is small or rudimentary; and to maintain as specifically distinct a number of forms differing in the absence of spines on the basal antennal joint and in the fourth antero-lateral tooth not being smaller than the rest, although Kossman regarded all these forms as conspecific with *Thalamita prymna* and Alcock (1899) endorsed his view.

Family *XANTHIDAE*

Subfamily XANTHINAE

Genus **Atergatis** De Haan

Atergatis integerrimus (Lamarck)

(Plate 8)

Cancer (*Atergatis*) *integerrimus*, De Haan, *Fauna Japonica* v, p. 45 (1850).
Atergatis integerrimus, de Man, *Journ. Linn. Soc. London* (*Zool.*) xxii, p. 24 (1887).
Walker, *Journ. Linn. Soc. London* (*Zool.*) xx, p. 109 (1890).
Henderson, *Trans. Linn. Soc. London* (*Zool.*) v, p. 352 (1893).
Alcock, *Journ. As. Soc. Bengal* lxvii, p. 95 (1898).
Lanchester, *Proc. Zool. Soc. London*, p. 730 (1900).
Laurie, *Ceylon Pearl Oyster Fish. Report* (5), p. 394 (1906).
Gravely, *Bull. Madras Govt. Mus.* i, p. 144 (1927).
Chopra and Das, *Rec. Ind. Mus.* xxxix, p. 397 (1937).
Sakai, *Yokendo Ltd. Tokyo*, p. 448 (1939).
Tweedie, *Bull. Raffles Mus.* 21, p. 87 (1950).

Numerous specimens, of both sexes, were collected at Bombay, Karwar, and Okha. It inhabits rocky places. A large male measures:—

length of carapace ...	64 mm.
breadth of carapace ...	98 mm.

This species is distinguished by the smooth carapace, without indications of regions, the edges of the antero-lateral borders being sharp and crest-like, and forming a ridge at the lateral epibranchial angle. There is almost no hair on the surface of the external maxillipeds, and there are no comb-like tufts of hair on the legs.

Colour brick-red, the pits on the carapace whitish, fingers black, with whitish tips and teeth.

In the specimens in the present collection, the walking legs, in addition to the usual little tuft of hairs near the far end of the lower border of the propodite, have a few stiff hairs in a similar position on the ischium; there is also a tuft of hair on the tooth on the inner border of the wrist of the chelipeds.

The anterior male abdominal appendage is bent sharply at the tip, which bears a few long hairs at the end and numerous spinules near it.

This species has a wide range of distribution, having been recorded from Japan to Zanzibar. It has been recorded so far in India only from the Bay of Bengal. This is the first record from the west coast of India.

Atergatis floridus (Rumph)

(Plate 8)

Cancer (*Atergatis*) *floridus*, De Haan, *Fauna Japonica* v, p. 46 (1850).
Atergatis floridus, Haswell, *Catalogue Austr. Crust.*, p. 41 (1882).
de Man, *Journ. Linn. Soc. London* (*Zool.*) xxii, p. 24 (1887).
Walker, *Journ. Linn. Soc. London* (*Zool.*) xx, p. 109 (1890).
Henderson, *Trans. Linn. Soc. London* (*Zool.*) v, p. 35 (1893).
Alcock, *Journ. As. Soc. Bengal* lxvii, p. 98 (1898).
Calman, *Trans. Linn. Soc. London* (*Zool.*) viii, p. 5 (1900).
Lanchester, *Proc. Zool. Soc. London*, p. 730 (1900).
Barnard, *Ann. S. Afr. Mus.* xxxviii, p. 207 (1950).
Tweedie, *Bull. Raffles Mus.* 21, p. 87 (1950).
Atergatis ocyroe, Suvatti, *Dept. of Fisheries, Bangkok, Thailand*, p. 163 (1950).

A male from Bombay represents the present collection. It measures :—

length of carapace	... 38 mm.
breadth of carapace	... 54 mm.

This species is distinguished by the lumpy carapace with broad, shallow depressions.

Colour yellowish pink, with symmetrically disposed spots and confluent blotches.

The anterior male abdominal appendages are somewhat similar to those of *Atergatis integerrimus*, in being tipped with spinules and hairs, but the hairs in this case are much longer.

This species has been previously recorded from South Africa, Red Sea, Andamans, Mergui, Laccadives, Karachi, Thailand, Philippines, Australia, and Japan. This is the first record from Bombay State.

Atergatis roseus (Ruppell)

(Plate 8)

Atergatis roseus, Alcock, *Journ. As. Soc. Bengal* lxvii, p. 97 (1898).

Three male specimens from Okha are in the present collection. It frequents rocky regions. The largest male measures :—

length of carapace	... 16 mm.
breadth of carapace	... 25 mm.

This species is distinguished by the edges of the antero-lateral borders being thick and blunt, and ending smoothly, without any ridge or tooth at the lateral epibranchial angle.

Colour during life a beautiful dark pink, with a narrow white lining on the sides, fingers blackish brown, with whitish tips and teeth. The colour fades in spirit.

The anterior male abdominal appendage is split into two at about half the length. Both the split parts bear tufts of hairs.

This species has been previously recorded from Madras and Karachi. This is the first record from Bombay State.

Genus **Platypodia**

Platypodia cristata (Milne-Edwards)

(Plate 8)

Lophactaea cristata, Alcock, *Journ. As. Soc. Bengal* lxvii, p. 100 (1898).
Borradaile, *Fauna Geog. Maldive Laccadive Archipel.* (3) i, p. 258 (1902).
Gravely, *Bull. Madras Govt. Mus.* i, p. 146 (1927).
Platypodia cristata, Rathbun, *Trans. Linn. Soc. London* (*Zool.*) (11) xiv, p. 214 (1911).
Barnard, *Ann. S. Afr. Mus.* xxxviii, p. 208 (1950).

Numerous specimens, of both sexes, from Okha are in the present collection. An average male measures :—

length of carapace	... 27 mm.
breadth of carapace	... 39 mm.

This species is distinguished by the carapace and the outer surfaces of the carpopodites and propodites of the legs being covered with pearly granules, and the upper border of the hand of the chelipeds being sharply crested.

Colour of the carapace bright pink, the crests whitish, fingers of the chelipeds black.

The anterior male abdominal appendage is elegantly bent at the tip, and carries spinules on its distal part.

This species has been previously recorded from Madras and Mauritius. This is the first record from the west coast of India.

Genus **Xantho** Leach

Subgenus **Lophoxanthus** Milne-Edwards

Xantho (Lophoxanthus) scaberrimus baccalipes Alcock

(Plate 8)

Xantho (*Lophoxanthus*) *scaberrimus,* **var.** *baccalipes*, Alcock, *Journ. As. Soc. Bengal* lxvii, p. 117 (1898).

The present collection is represented by two males from Bombay. The larger one measures :—

length of carapace	... 45 mm.
breadth of carapace	... 60 mm.

This variety is distinguished by the worn appearance of the tubercles on the carapace and chelipeds; the dorsal surfaces of the arm of the chelipeds and meropodites of the legs are covered with a row of berry-like teeth.

Colour a deep brick-red. Fingers of chelipeds dark brown in their basal half, white at the tips.

There is a tendency for the antero-lateral borders to continue beneath the orbits to the angles of the buccal cavern, as in *Medaeus*.

The anterior male abdominal appendages are thin, covered with backward projecting spinules, five of which are situated close together near the tip where, also, are about 16 barbed hairs.

It has been previously recorded from Ceylon. This is the first record of this variety from India.

Genus **Leptodius** Milne-Edwards

Leptodius exaratus (Milne-Edwards)

(Plate 8)

Leptodius exaratus, Haswell, *Catalogue Austr. Crust.*, p. 60 (1882).
de Man, *Journ. Linn. Soc. London* (*Zool.*) xxii, p. 33 (1887).
Henderson, *Trans. Linn. Soc. London* (*Zool.*) v, p. 362 (1893).
Lanchester, *Proc. Zool. Soc. London*, p. 738 (1900).
Rathbun, *Trans. Linn. Soc. London* (*Zool.*) (11) xiv, p. 215 (1911).
Shen, *Inst. Zool. Nat. Acad. Peiping* iii, p. 61 (1936).
Chopra and Das, *Rec. Ind. Mus.* xxxix, p. 398 (1937).
Shen, *Bull. Fan Mem. Inst. Biol.* (*Zool.*) vii, p. 175 (1937).
Shen, *Bull. Fan Mem. Inst. Biol.* (*Zool.*) x, p. 85 (1940).
Suvatti, *Dept. of Fisheries, Bangkok, Thailand*, p. 164 (1950).
Lepthodius exaratus, Maccagno, *Ann. Mus. Stor. nat. Genova* lix, p. 174 (1935-1937).
Xantho (*Leptodius*) *exaratus*, Alcock, *Journ. As. Soc. Bengal* lxvii, p. 118 (1898).
Calman, *Trans. Linn. Soc. London* (*Zool.*) vii, p. 6 (1900).
Laurie, *Ceylon Pearl Oyster Fish. Report* (5), p. 402 (1906).
Gravely, *Bull. Madras Govt. Mus.* i, p. 146 (1927).
Sakai, *Yokendo Ltd. Tokyo*, p. 464 (1939).
Xantho exaratus, Gordon, *Journ. Linn. Soc. London* (*Zool.*) xxxvii, p 543 (1930-1932).
Xantho hydrophilus, Montgomery, *Journ. Linn. Soc. London* (*Zool.*) xxxvii, p. 435 (1931).

Numerous specimens, of both sexes, were collected at various places around Bombay. It lives among rocks. An average male measures :—

length of carapace	... 21 mm.
breadth of carapace	... 31 mm.

This species is distinguished by the antero-lateral border being cut into four teeth, and the postero-lateral border being equal in length to the chord of the antero-lateral border.

Colour a dirty purple grey, fingers of chelipeds black, with whitish tips. In the young, there is a vertical white band in the middle of the carapace ; this fades in spirit.

There seems to be a great deal of variation in the shape and acuteness of the lateral lobes and teeth of the carapace; in young crabs, the lobes are usually less distinct and the teeth are blunter.

The anterior male abdominal appendage is bent at the tip like a ploughshare. The tip bears spinules and its edges are serrated.

This species has been previously recorded from both the Bay of Bengal and the Arabian Sea, including Bombay, also from the Persian Gulf, Polynesia, Australia, Malaya, Ceylon, Maldives and Laccadives, Red Sea, and Seychelles.

Leptodius crassimanus Milne-Edwards

(Plate 9)

Leptodius crassimanus, Haswell, *Catalogue Austr. Crust.*, p. 61 (1882).
Xantho (*Leptodius*) *crassimanus*, Alcock, *Journ. As. Soc. Bengal* lxvii, p. 120 (1898).

Numerous specimens, of both sexes, were collected from Bombay. It lives among rocks. An average male measures :—

length of carapace	... 26 mm.
breadth of carapace	... 41 mm.
breadth of front	... 8 mm.

This species is distinguished by the narrow front with the edges of its lobes deeply concave, so that it appears to be quadridentate, and the antero-lateral borders cut into five teeth.

Colour dirty yellow or grey, fingers of chelipeds black with whitish tips.

The anterior male abdominal appendage is curved, and has its tip flat and arrow-headed and covered with long spines.

This species has been previously recorded from the Andamans, Karachi, and Australia. This is the first record from Bombay State.

Leptodius euglyptus quadrispinosus Chhapgar

(Plate 9)

Leptodius euglyptus quadrispinosus, Chhapgar, *Rec. Ind. Mus.* liii (1955) (in press).

Numerous adult specimens, of both sexes, were collected among rocks from Okha.

A male of average size gave the following measurements :—

length of carapace	... 10.0 mm.
breadth of carapace	... 14.5 mm.

Though the specimens greatly resemble *Leptodius euglyptus* Alcock, they differ from the latter in some important respects, and a detailed description of a typical specimen is, therefore, given below.

Carapace two-third as long as broad, rather strongly convex in its anterior two-thirds, flat posteriorly; its regions well delimited, convex, and as completely areolated as any *Actaea*—the areolae being strongly convex and somewhat pitted transversely.

Front projecting beyond the orbit, from which it is separated by a notch, cut into two lobes of which the outer angle is prominent; its breadth is not quite a third of the carapace.

Antero-lateral borders cut into four conical teeth, not including the outer angle of the orbit, or a small denticle below it; postero-lateral borders strongly convergent, as long as the chords of the antero-lateral borders.

Chelipeds unequal; the upper and outer surfaces of the wrist strongly wrinkled and pitted; the upper surface of the hand nodular, upper half or more of the outer surface of the hand longitudinally ridged and transversely wrinkled; fingers short, stout, hollowed (but not broadened) at the tip.

Legs with the carpopodite and propodite longitudinally ridged and grooved above—the carpus more distinctly so; the dactylus furred.

Side walls of carapace, edges of the upper surface of the arm, and edges of legs, especially the upper edge of the meropodites, hairy.

Colour, during life, of carapace pink, a white longitudinal band from the front across the gastric region, fingers of chelipeds and front lower corner of the hands blackish brown.

This variety resembles *Leptodius euglyptus* Alcock in the sharp *Actaea*-like sculpture of the carapace, but differs from it in having only four teeth on the antero-lateral borders, as well as in the relationship of the lengths of the antero-lateral and postero-lateral borders. In this case, the postero-lateral borders are as long as the chord of the antero-lateral borders, whereas in *Leptodius euglyptus* Alcock they are shorter than the chord of the antero-lateral borders.

The anterior male abdominal appendages are elegantly bent, serrulate near the tip, proximal to which are about 12 to 15 larger spinules. These spinules do not extend up to the tip. (In *Leptodius euglyptus* Alcock the spinules are longer and sharper and extend right up to the tip; the serrulations also are sharper and form only a single row.)

Genus **Medaeus** Dana

Medaeus granulosus (Haswell)

(Plate 9)

Medaeus granulosus, Gordon, *Journ. Linn. Soc. London* (*Zool.*) xxxvii, p. 543 (1931).
Sakai, *Yokendo Ltd. Tokyo*, p. 459 (1939).

The present collection is represented by five males from Bombay and Okha. An average specimen measures:—

length of carapace	... 13 mm.
breadth of carapace	... 19 mm.

This species is distinguished by the antero-lateral borders being distinctly continued beneath the orbits to the angles of the buccal cavern. The carapace is two-third as long as broad, with numerous short, transverse rows of bead-like granules on its anterior half. These are more scattered on the hinder regions, but are distinct on the posterior border and between the four antero-lateral teeth.

Colour ashy grey. Fingers of chelipeds chocolate brown.

The anterior male abdominal appendages have their sides with backward projecting spinules. Near the tip are numerous barbed hairs. The appendages show a marked resemblance to those of *Xantho* (*Lophoxanthus*) *caberrimus baccalipes.*

Genus **Etisus** Milne-Edwards

Etisus laevimanus Randall

(Plate 9)

Etisus laevimanus, Haswell, *Catalogue Austr. Crust.*, p. 54 (1882).
Henderson, *Trans. Linn. Soc. London* (*Zool.*) v, p. 362 (1893).
Alcock and Anderson, *Journ. As. Soc. Bengal* lxiii, p. 200 (1894).
Alcock, *Journ. As. Soc. Bengal* lxvii, p. 131 (1898).
Calman, *Trans. Linn. Soc. London* (*Zool.*) vii, p. 7 (1900).
Lanchester, *Proc. Zool. Soc. London*, p. 738 (1900).
Borradaile, *Fauna Geog. Maldive Laccadive Archipel.* (3) i, p. 263 (1902).
Rathbun, *Trans. Linn. Soc. London* (*Zool.*) (11) xiv, p. 217 (1911).
Gravely, *Bull. Madras Govt. Mus.* i, p. 146 (1927).
Sakai, *Yokendo Ltd. Tokyo*, p. 497 (1939).

Numerous specimens, of both sexes, from Bombay and Okha are represented in the present collection. The largest measures :—

length of carapace	...	28 mm.
breadth of carapace	...	44 mm.

This species is distinguished by the four-toothed antero-lateral borders, the tooth at the inner angle of the lower border of the orbit being in contact with the eave of the orbit beyond the tip of the process of the basal antennal joint, the legs being spineless, and the fingers of the chelipeds broadened and hoof-like.

Colour patchy orange and white, fingers of chelipeds black.

The anterior male abdominal appendages are bent at the tip at a plane right angles to the plane of the body ; the tip bears saw-like teeth.

This species has been previously recorded from Karachi, Bombay, Persian Gulf, Laccadives, Andamans, Singapore, Celebes, and Mauritius.

Genus **Galene** De Haan

Galene bispinosa (Herbst)

(Plate 9)

Cancer (*Galene*) *bispinosus*, De Haan, *Fauna Japonica* v, p. 49 (1850).
Galene bispinosa, Walker, *Journ. Linn. Soc. London* (*Zool.*) xx, p. 110 (1890).
Alcock, *Journ. As. Soc. Bengal* lxvii, pp. 136, 137 (1898).
Chopra, *Rec. Ind. Mus.* xxxvii, pp. 509, 510 (1935).

Two males from Bombay are in the present collection. The larger one measures :—

length of carapace	...	40 mm.
breadth of carapace	...	58 mm.

This species is distinguished by the convex carapace, with the slightly granular antero-lateral borders indistinctly four-lobed. The chelipeds are massive and unequal, and bear pointed fingers. All joints of the abdomen are distinct.

Colour during life pinkish.

The anterior male abdominal appendages are long and straight. The tip bears a peculiar blunt finger-like process on the outer margin, with two rows of spines proximal to it.

This species has been previously recorded from Vizagapatam and the Ganges Delta, as well as Hong Kong and Japan. This is the first record from the west coast of India.

Subfamily ACTAEINAE

Genus **Actaea** De Haan

Actaea savignyi (Milne-Edwards)

(Plate 9)

Cancer (Actaea) granulatus, De Haan, *Fauna Japonica* v, p. 47 (1850).
Actaea granulata, Miers, *Catalogue New Zealand Crust.*, p. 16 (1876).
Haswell, *Catalogue Austr. Crust.*, p. 44 (1882).
Henderson, *Trans. Linn. Soc. London* (*Zool.*) v, p. 356 (1893).
Alcock and Anderson, *Journ. As. Soc. Bengal* lxiii, p. 200 (1894).
Alcock, *Journ. As. Soc. Bengal* lxvii, p. 151 (1898).
Lanchester, *Proc. Zool. Soc. London*, p. 732 (1900).
Borradaile, *Fauna Geog. Maldive Laccadive Archipel.* (3) i, p. 256 (1902).
Laurie, *Ceylon Pearl Oyster Fish. Report* (5), p. 405 (1906).
Actaea savignyi, Rathbun, *Trans. Linn. Soc. London* (*Zool.*) (11) xiv, p. 221 (1911).
Montgomery, *Journ. Linn. Soc. London* (*Zool.*) xxxvii, p. 438 (1931).
Sakai, *Yokendo Ltd. Tokyo*, p. 485 (1939).
Shen, *Bull. Fan Mem. Inst. Biol.* (*Zool.*) x, p. 85 (1940).
Barnard, *Ann. S. Afr. Mus.* xxxviii, p. 231 (1950).
Suvatti, *Dept. of Fisheries, Bangkok, Thailand*, p. 163 (1950).

Numerous specimens, of both sexes, from Okha are in the present collection. An average male measures :—

length of carapace	... 13 mm.
breadth of carapace	... 17 mm.

This species is distinguished by its mulberry-like carapace, owing to its entire surface being covered with confluent tubercles, each tubercle again being formed of confluent granules. These tend to be spiny on the legs.

Colour light reddish brown, fingers black with white tips.

The anterior male abdominal appendages are narrowed and hook-like at the tip with a few spines and numerous feathery hairs.

This species has been previously recorded from Seychelles, Persian Gulf, Red Sea, India, Ceylon, Maldives and Laccadives, Malaya, Hong Kong, Australia, New Zealand, Karachi, Ganjam coast, Mergui, and Malacca. This is the first record from Bombay State.

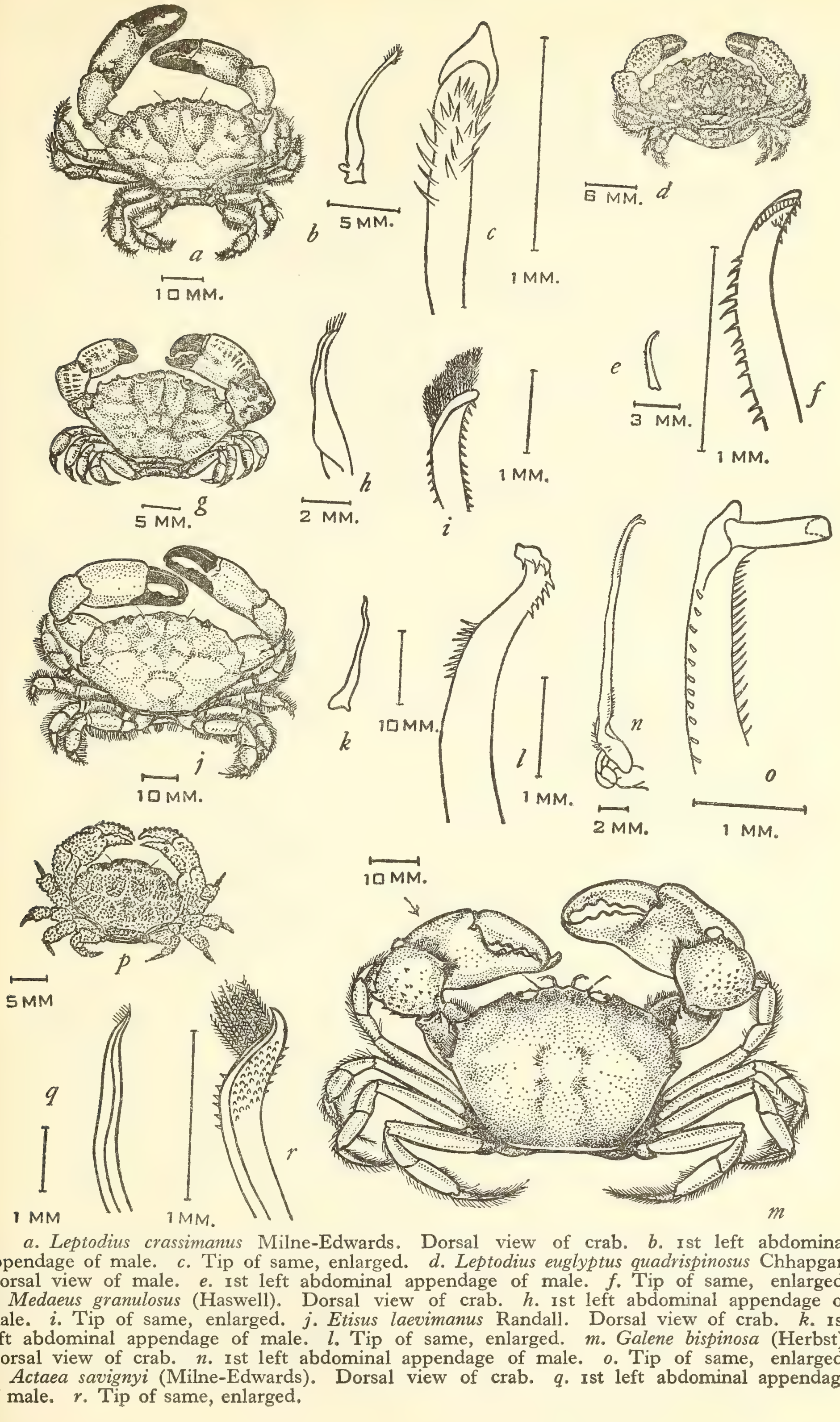
Subfamily MENIPPINAE

Genus **Myomenippe** Hilgendorf

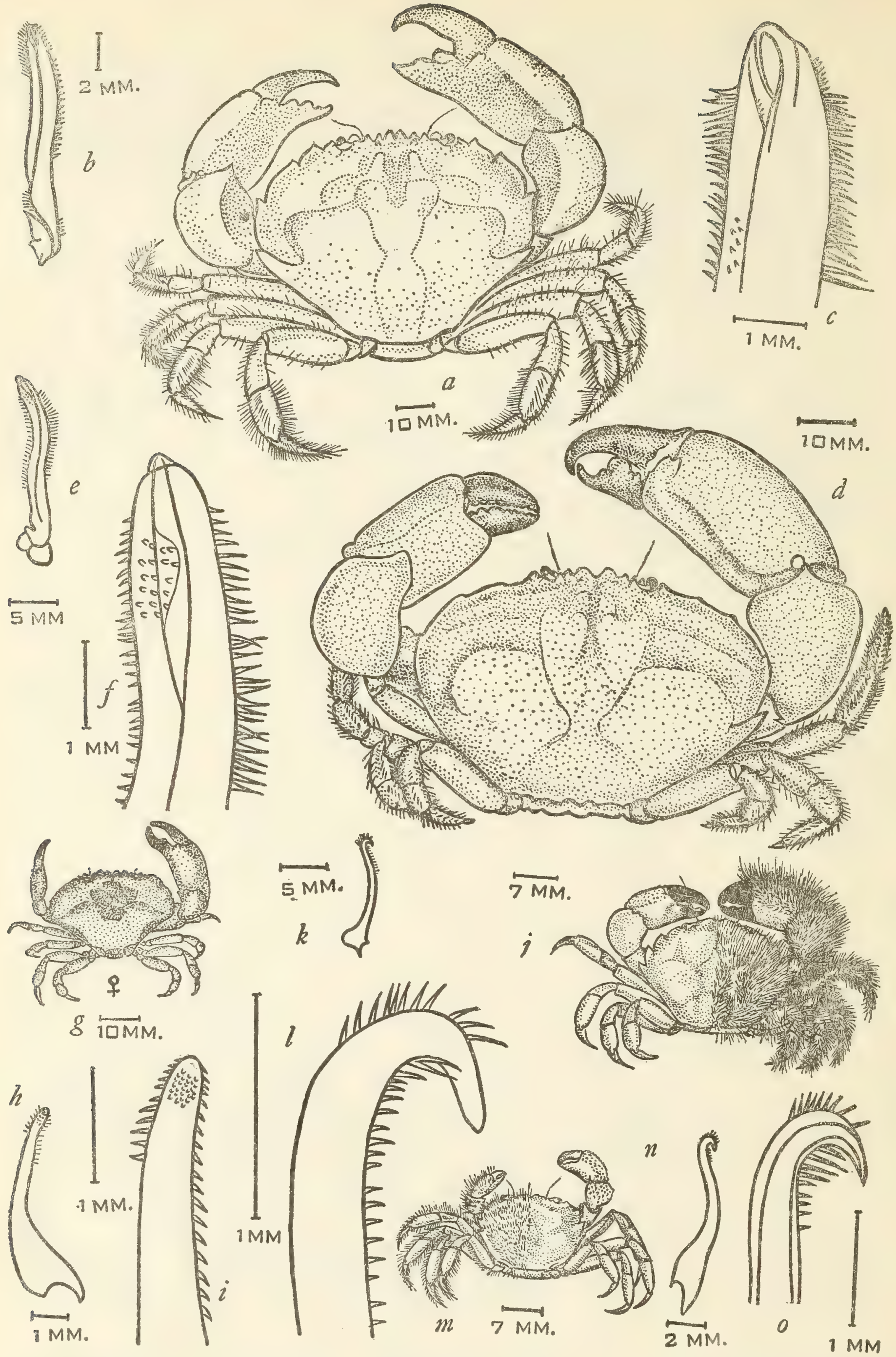
Myomenippe hardwickii (Gray)

(Plate 10)

Myomenippe granulosa, de Man, *Journ. Linn. Soc. London* (*Zool.*) xxii, p. 40 (1887).
Lanchester, *Proc. Zool. Soc. London*, p. 740 (1900).
Suvatti, *Dept. of Fisheries, Bangkok, Thailand*, p. 166 (1950).


a
10 MM.
b
5 MM.
c
1 MM.
6 MM. d
e
3 MM.
f
1 MM.
g
5 MM.
h
2 MM.
i
1 MM.
j
10 MM.
k
10 MM.
l
1 MM.
n
2 MM.
o
1 MM.
10 MM.
p
5 MM
q
1 MM
1 MM.
r
m

a. Leptodius crassimanus Milne-Edwards. Dorsal view of crab. *b.* 1st left abdominal appendage of male. *c.* Tip of same, enlarged. *d. Leptodius euglyptus quadrispinosus* Chhapgar. Dorsal view of male. *e.* 1st left abdominal appendage of male. *f.* Tip of same, enlarged. *g. Medaeus granulosus* (Haswell). Dorsal view of crab. *h.* 1st left abdominal appendage of male. *i.* Tip of same, enlarged. *j. Etisus laevimanus* Randall. Dorsal view of crab. *k.* 1st left abdominal appendage of male. *l.* Tip of same, enlarged. *m. Galene bispinosa* (Herbst). Dorsal view of crab. *n.* 1st left abdominal appendage of male. *o.* Tip of same, enlarged. *p. Actaea savignyi* (Milne-Edwards). Dorsal view of crab. *q.* 1st left abdominal appendage of male. *r.* Tip of same, enlarged.


2 MM.
b
a
10 MM.
c
1 MM.
10 MM.
d
e
5 MM
f
1 MM
5 MM.
k
7 MM.
j
♀
g
10 MM.
l
1 MM
h
1 MM.
i
1 MM.
n
m
7 MM.
2 MM.
o
1 MM

a. Myomenippe hardwickii (Gray). Dorsal view of crab. *b.* 1st left abdominal appendage of male. *c.* Tip of same, enlarged. *d. Ozius rugulosus* Stimpson. Dorsal view of crab. *e.* 1st left abdominal appendage of male. *f.* Tip of same, enlarged. *g. Epixanthus frontalis* (Milne-Edwards). Dorsal view of crab. *h.* 1st left abdominal appendage of male. *i.* Tip of same, enlarged. *j. Pilumnus vespertilio* (Fabricius). Dorsal view of crab. *k.* 1st left abdominal appendage of male. *l.* Tip of same, enlarged. *m. Pilumnus longicornis* Hilgendorf. Dorsal view of crab. *n.* 1st left abdominal appendage of male. *o.* Tip of same, enlarged.

Menippe (*Myomenippe*) *granulosa,* Alcock, *Journ. As. Soc. Bengal* lxvii, p. 179 (1898).
Myomenippe hardwickii, Chopra & Das, *Rec. Ind. Mus.* xxxix, p. 404 (1937).

The present collection is represented by two females from Bombay. It lives among rocks. The larger specimen measures :—

length of carapace	... 45 mm.
breadth of carapace	... 64 mm.

The antero-lateral border is thin and rather sharp and is cut into four teeth. The front is bilobed, each lobe being cut into three teeth. The inner lower angle of the orbit is as prominent as the innermost lobule of the frontal lobes.

Colour chocolate grey, fingers of chelipeds black.

According to Chopra & Das (1937), the anterior male abdominal appendages are short and stout and are rounded at the tip. The usual ciliated channel is entirely closed, leaving only an oval aperture near the distal end. The sides are beset with long stout hairs.

This species has been previously recorded from the Bay of Bengal, Mergui, Singapore, and Dar-es-Salaam on the east coast of Africa. This is the first record from the west coast of India.

Subfamily OZIINAE

Genus **Ozius** Milne-Edwards

Ozius rugulosus Stimpson

(Plate 10)

Ozius rugulosus, Haswell, *Catalogue Austr. Crust.*, p. 63 (1882).
Alcock, *Journ. As. Soc. Bengal* lxvii, p. 182 (1898).
Gravely, *Bull. Madras Govt. Mus.* i, p. 145 (1927).
Sakai, *Yokendo Ltd. Tokyo,* p. 518 (1939).
Pillai, *Bull. Central Inst. Travancore* ii, p. 15 (1951).

Numerous specimens, of both sexes, were caught at Bombay and Karwar. It lives among rocks. An average male measures :—

length of carapace	... 46 mm.
breadth of carapace	... 66 mm.

This species is distinguished by the smooth carapace without any tubercles, it being two-third as long as broad. The surface of the wrists and hands of the chelipeds is reticulate-rugulose.

Colour dark reddish or violet brown, fingers of chelipeds black, teeth and tips white.

In the specimens in the present collection, the front is cut into four equidistant teeth, but the two inner teeth are far bigger than the outermost ones. Only the upper surface of the carpopodites of the legs is hairy. The antennae are more than $1\frac{3}{4}$ times the width of the orbit in length.

The anterior male abdominal appendages are bluntly tipped, like the tip of a banana. The sides are beset with long stout hairs, and there is an oval patch of spinules near the tip.

This species has been previously recorded from India, Ceylon, Andamans and Nicobars, Australia, New Caledonia, and Tahiti. This is the first record from Bombay State.

Genus **Epixanthus** Heller

Epixanthus frontalis (Milne-Edwards)

(Plate 10)

Epixanthus frontalis, de Man, *Journ. Linn. Soc. London* (*Zool.*) xxii p. 46 (1887).
Henderson, *Trans. Linn. Soc. London* (*Zool.*) v, p. 364 (1893).
Alcock, *Journ. As. Soc. Bengal* lxvii, p. 185 (1898).
Laurie, *Ceylon Pearl Oyster Fish. Report* (5), p. 408 (1906).
Chopra and Das, *Rec. Ind. Mus.* xxxix, p. 405 (1937).
Sakai, *Yokendo Ltd. Tokyo*, p. 519 (1939).
Barnard, *Ann. Mag nat. hist.* xiii, p. 365 (1946).
Barnard, *Ann. S. Afr. Mus.* xxxviii, p. 259 (1950).
Suvatti, *Dept. of Fisheries, Bangkok, Thailand*, p. 167 (1950).

The present collection is represented by a male and a female from Bombay. It lives among rocks. The male measures :—

length of carapace	...	20 mm.
breadth of carapace	...	33 mm.
breadth of front	...	11 mm.

This species is distinguished by the smooth, almost flat carapace, with the antero-lateral borders divided by very short narrow fissures into four broad and shallow lobes.

Colour dirty yellowish or bluish brown, fingers chocolate brown.

In the male in the present collection, the fourth lobe of the antero-lateral borders is further subdivided by a slight fissure, there being thus five lobes. In addition to the bluntly pointed inner angle of the wrist, there is a subterminal denticle on the same border.

The anterior male abdominal appendages are slightly curved; the tip is blunt and bears minute spinules in a patch at the end. Longer spinules occur along the borders.

This species has been previously recorded from the Bay of Bengal as well as the Arabian Sea. It is also known to occur from Tasmania to the east coast of Africa and the Red Sea.

Subfamily PILUMNINAE

Genus **Pilumnus** Leach

Pilumnus vespertilio (Fabricius)

(Plate 10)

Pilumnus vespertilio, Miers, *Catalogue New Zealand Crust.*, p. 19 (1876).
Haswell, *Catalogue Austr. Crust.*, p. 65 (1882).
de Man, *Journ. Linn. Soc. London* (*Zool.*) xxii, p. 58 (1887).
Walker, *Journ. Linn. Soc. London* (*Zool.*) xx, p. 110 (1890).
Henderson, *Trans. Linn. Soc. London* (*Zool.*) v, p. 365 (1893).
Alcock and Anderson, *Journ. As. Soc. Bengal* lxiii p. 201 (1894).
Alcock, *Journ. As. Soc. Bengal* lxvii, p. 192 (1898).
Lanchester, *Proc. Zool. Soc. London*, p. 743 (1900).

Borradaile, *Fauna Geog. Maldive Laccadive Archipel.* (3) i, p. 245 (1902).
Laurie, *Ceylon Pearl Oyster Fish. Report* (5), p. 408 (1906).
Barnard, *Ann. S. Afr. Mus.* xxxviii, p. 263 (1950).
Suvatti, *Dept. of Fisheries, Bangkok, Thailand,* p. 167 (1950).

Numerous specimens, of both sexes, were collected from Bombay and Okha. An average male measures :—

length of carapace	... 22 mm.
breadth of carapace	... 28 mm.
breadth of front	... 8 mm.

This species can be distinguished by the upper margin of the orbit having two distinct notches, the outer orbital angle being sharp but not spinular, and the presence of a subhepatic spine just below it. The carapace, legs, and chelipeds (with the exception of the fingers and the lower border of the hand) are concealed by a thick, dark, shaggy coat of hair.

There seem to be two colour variations :—

(1) with greyish white carapace (when denuded), tending to a very faint blue ;

(2) a whitish carapace blotched with bright brick-red, legs striped with the same colours.

In the specimens in the present collection, the upper surface of the meropodites of the legs is not hairy.

The anterior male abdominal appendages are bent upon themselves at the tip to form a hook ; the borders bear spines.

This species has been previously recorded from Karachi, Tavoy, Mergui, and the Andamans. This is the first record from Bombay State.

Pilumnus longicornis Hilgendorf

(Plate 10)

Pilumnus longicornis, Alcock, *Journ. As. Soc. Bengal* lxvii, p. 193 (1898).
Laurie, *Ceylon Pearl Oyster Fish. Report* (5), p. 408 (1906).
Rathbun, *Trans. Linn. Soc. London (Zool.)* (11) xiv, p. 228 (1910-1912).
Chopra and Das, *Rec. Ind. Mus.* xxxix, p. 406 (1937).
Suvatti, *Dept. of Fisheries, Bangkok, Thailand,* p. 167 (1950).

The present collection is represented by two males from Okha. It lives in the mud under stones. The larger male measures :—

length of carapace	... 13 mm.
breadth of carapace	... 17 mm.
breadth of front	... 5.5 mm.

This species is distinguished by the absence of a subhepatic spine below the outer orbital angle. The free edge of the front, which is very prominent, and the upper margin of the orbit, are finely denticulate. The carapace is covered with a fine, short fur among which are numerous long, silky bristles.

Colour of the denuded carapace a very light pinkish red, which fades to grey in alcohol; fingers of chelipeds brown.

In the specimens in the present collection, the external margin of the second tooth of the antero-lateral borders is distinctly bluntly spinate, that of the third obscurely so.

The anterior male abdominal appendages are bent sharply upon themselves at the tip, which bears spines, five or six on the inner border being larger.

This species has been previously recorded trom both the coasts of India, including Bombay, as well as from Thailand and Seychelles.

Genus **Heteropanope** Stimpson

Heteropanope laevis (Dana)

(Plate 11)

Heteropanope laevis, Alcock, *Journ. As. Soc. Bengal* lxvii, p. 209 (1898).

The present collection is represented by a male and two females from Okha. The male measures :—

length of carapace	...	9 mm.
breadth of carapace	...	12.5 mm.

This species is distinguished by the convex carapace and smooth chelipeds.

Colour greyish yellow.

The anterior male abdominal appendages are S-shaped. The tip is bent over itself and carries five spinules on the inner border.

This species has been previously recorded from Karachi and Bombay.

Genus **Eurycarcinus** Milne-Edwards

Eurycarcinus orientalis (Milne-Edwards)

(Plate 11)

Eurycarcinus orientalis, Alcock, *Journn. As. Soc. Bengal* lxvii, p. 210 (1898).
Suvatti, *Dept. of Fisheries, Bangkok, Thailand*, p. 166 (1950).
Pillai, *Bull. Central Inst. Travancore* ii, p. 16 (1951).

Numerous specimens, of both sexes, from Bombay, Kolak, and Umarsadi are in the present collection. An average male measures :—

length of carapace	...	18 mm.
breadth of carapace	...	25 mm.
length of antero-lateral border	...	8 mm.
length of postero-lateral border	...	14 mm.

This species is distinguished by the antero-lateral borders, being less than two-third the length of the postero-lateral borders, and the thumb of the larger cheliped with an enlarged tooth at its base.

Colour bright pink, fading to yellowish brown in spirit.

The tooth at the base of the thumb of the larger cheliped is not so enlarged in young specimens.

The anterior male abdominal appendages are bent sharply back at the tips in the form of a hook bearing three large spinules and five to six smaller ones.

This species has been previously recorded from Karachi, Bombay the Andamans, and Thailand.

Subfamily *ERIPHINAE*

Genus **Eriphia** Latreille

Eriphia laevimana smithii Macleay

(Plate 11)

Eriphia laevimana smithii, Walker, *Journ. Linn. Soc. London* (*Zool.*) xx, p. 110 (1890).
Alcock, *Journ. As. Soc. Bengal* lxvii. p. 216 (1898).
Lanchester, *Proc. Zool. Soc. London*, p. 744 (1900).
Sakai, *Yokendo Ltd. Tokyo*, p. 523 (1939).
Shen, *Bull. Fan Mem. Inst. Biol.* (*Zool.*) x, p. 86 (1940).
Eriphia smithii, Barnard, *Ann. S. Afr. Mus.* xxxviii, p. 274 (1950).

The present collection is represented by a male and a female from Okha. The male measures :—

length of carapace	... 46 mm.
breadth of carapace	... 59 mm.

This variety is distinguished by the absence of hairs on the carapace, which is four-fifth as long as broad, the frontal lobes being bluntly spinate, and the hand and wrist of the smaller cheliped being covered with tubercles.

Colour dull maroon, fingers of chelipeds chocolate brown, teeth and tips white.

The anterior male abdominal appendages are sharply tipped like a scalpel; the tip bears a row of spines along the inner border and a few spinules placed haphazardly.

This variety has been previously recorded from Karachi and the Mekran coast. This is the first record from Bombay State.

Family *GONEPLACIDAE*

Subfamily PSEUDORHOMBILINAE

Genus **Eucrate** De Haan

Eucrate crenata dentata (Stimpson)

(Plate 11)

Heteroplax (?) *dentatus*, Walker, *Journ. Linn. Soc. London* (*Zool.*) xx, p. 110 (1890).
Eucrate crenata, var. *dentata*, Alcock, *Journ. As. Soc. Bengal* lxix, p. 301 (1900).

Six berried females from Bombay represent the present collection. An average specimen measures :—

length of carapace	... 20 mm
breadth of carapace	... 25 mm.

This variety is distinguished by the antero-lateral borders of the carapace being cut into four teeth of which the second and fourth are quite inconspicuous. The median notch of the front is almost obsolete. The chelipeds bear a patch of fur at the far end of the upper surface of the wrist.

Colour bright yellow, with minute red spots scattered throughout. One of the specimens has two black squarish patches on the outer sides of the gastric region.

The local specimens are very large compared to other *Eucrate crenata* so far recorded in India. This variety probably visits the Bombay shore only for breeding, as they are not found throughout the year. Two berried females were caught in the first week of December, 1952. After this, despite exhaustive search, no more specimens were found till the last week of November, 1953, when again four berried females were caught.*

This variety has been previously recorded from the Red Sea, Palk Straits, and Hong Kong. This is the first record from the west coast of India.

Genus **Litocheira** Kinahan

Litocheira angustifrons Alcock

(Plate 11)

Litocheira angustifrons, Alcock, *Journ. As. Soc. Bengal* lxix, p. 315 (1900).
Borradaile, *Fauna Geog. Maldive Laccadive Archipel.* (5) i, p. 430 (1903).
Tesch, *Siboga Exped. Rep.* xxxix, p. 411 (1918).

The present collection is represented by numerous specimens from Bombay. It lives in mud. An average male measures :—

length of carapace	... 9.4 mm.
breadth of carapace	... 11.8 mm.
breadth of front	... 3.6 mm.

This species is distinguished by the carapace being two-third as long as broad, the antero-lateral borders being arched and cut into three teeth.

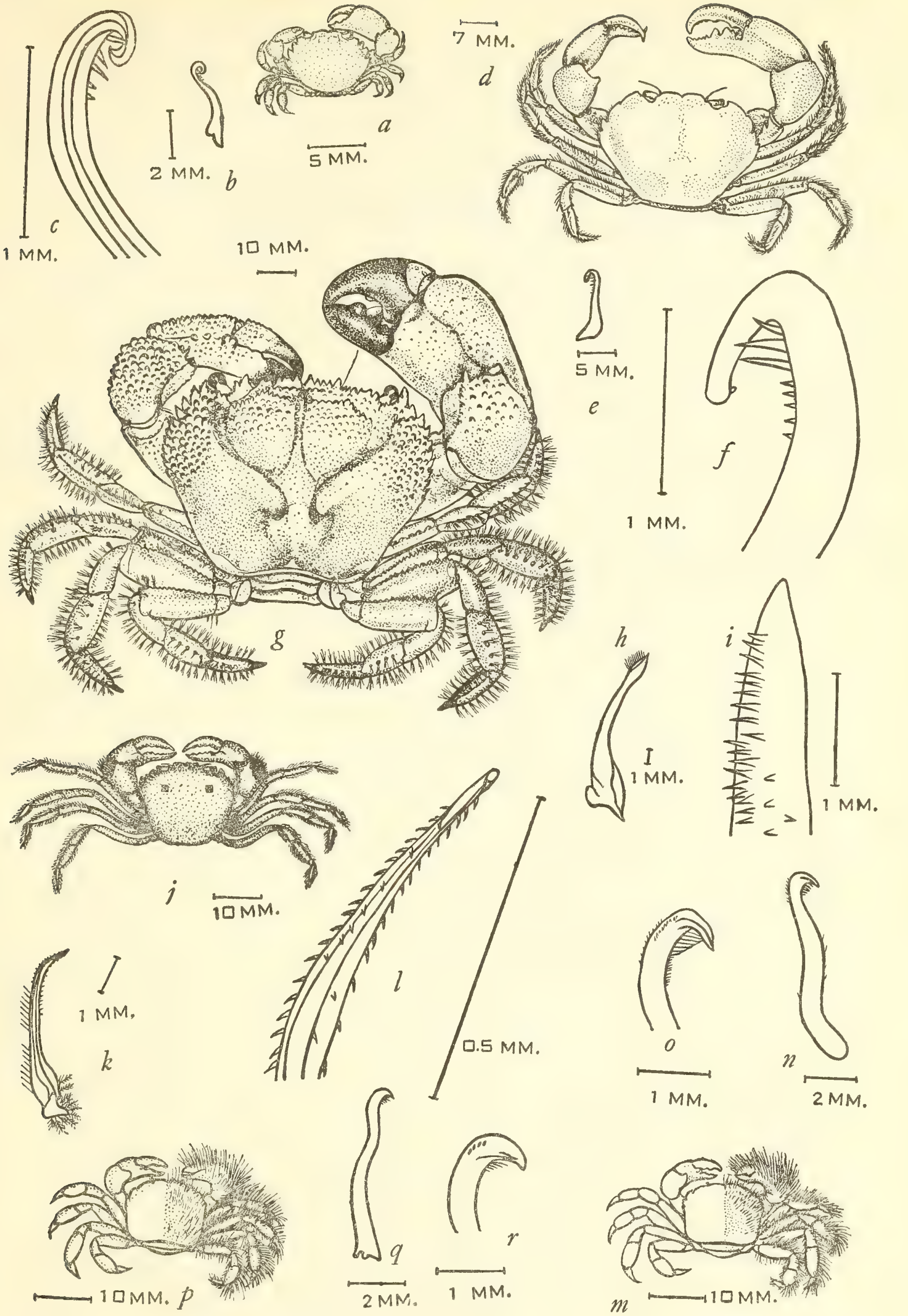
Colour dirty light brownish, fingers white or light brown.

The anterior male abdominal appendages have the apex bent outwards and considerably upwards. Just behind the tip on the outer side is a tuft of long hairs decreasing in size distally, and a few minute spinules on the inner border.

This species has been previously recorded from Bombay, Karachi, Maldives, and Mergui Archipelago.

---

*Two male specimens of this crab were caught in the same locality in December, 1955. The anterior male abdominal appendages are bent at right angles at the tip, which is transparent and of a golden yellow colour. The appendage bears rows of short backwardly directed spines.


c
1 MM.
2 MM.
b
a
5 MM.
7 MM.
d
10 MM.
5 MM.
e
1 MM.
f
g
h
1 MM.
i
1 MM.
j
10 MM.
1 MM.
k
l
0.5 MM.
o
1 MM.
n
2 MM.
10 MM.
p
q
2 MM.
r
1 MM.
m
10 MM.

a. Heteropanope laevis (Dana). Dorsal view of crab. *b.* 1st left abdominal appendage of male. *c.* Tip of same, enlarged. *d. Eurycarcinus orientalis* Milne-Edwards. Dorsal view of crab. *e.* 1st left abdominal appendage of male. *f.* Tip of same, enlarged. *g. Eriphia laevimana smithii* Macleay. Dorsal view of crab. *h.* 1st left abdominal appendage of male. *i.* Tip of same, enlarged. *j. Eucrate crenata dentata* (Stimpson). Dorsal view of crab. *k.* 1st left abdominal appendage of male. *l.* Tip of same, enlarged. *m. Litocheira angustifrons* Alcock. Dorsal view of crab. *n.* 1st left abdominal appendage of male. *o.* Tip of same, enlarged. *p. Litocheira setosa* (Milne-Edwards). Dorsal view of crab. *q.* 1st left abdominal appendage of male. *r.* Tip of same, enlarged.

Litocheira setosa (Milne-Edwards)

(Plate 11)

Litocheira setosa, Alcock, *Journ. As. Soc. Bengal* lxix, p. 315 (1900).
Tesch, *Siboga Exped. Rep.* xxxix, p. 165 (1918).
Suvatti, *Dept. of Fisheries, Bangkok, Thailand,* p. 161 (1950).

A male from Okha is in the present collection. It measures :—

length of carapace	... 11 mm.
breadth of carapace	.. 13.1 mm.
breadth of front	.. 4.1 mm.

This species is distinguished by the antero-lateral borders being arched and cut into two teeth.

Colour dirty white, fingers white.

The anterior male abdominal appendages are bent at the tip, which bears a few hairs on its outer border and a few minute spinules on the inner border.

This species has been previously recorded from the Andamans and Mergui. This is the first record from the west coast of India.

(*To be continued*)

OBITUARY

Brigadier W. H. Evans, C.S.I., C.I.E., D.S.O., R.E.

One of the most distinguished entomologists of our time has been lost to us by the death in November 1956 at the age of 80 of Brigadier Evans. He was born in Shillong, Assam, in 1876, his father General Sir Horace Evans being there in command of the 8th Gurkha Rifles. As a Royal Engineer he saw service with the Somaliland Field Force in 1903 to 1904, and in France in the 1914-1918 War. In 1927 he was appointed Chief Engineer, Western Command, and retired in 1931.

His first contribution to the journal of the B.N.H.S. was in 1912 and he sent articles to the *Journal* on the Identification of Indian Butterflies, including those of Burma and Ceylon, from 1922-26. These were published in book form in 1927, a surprising achievement for one who had always worked hard in his profession as a Royal Engineer.

The Keys constructed by him have stood the test of time and have been largely used as the basis for the Keys of Talbot in the two volumes of 1939 and 1947 of his revision of part of Bingham's Butterflies of India, Ceylon and Burma in the Fauna of India series. Not only are the keys notable, but the number of species and subspecies newly named by him is large.

For the Hesperiidae alone he named 2 new genera and 37 new species. He did not live near a museum and its library, and his specimens were those he could catch himself or procure from Indian collectors or from Tytler who collected in Manipur and the Naga Hills from 1911-1914. His only extensive trips were for five months in Burma in 1920-21 and two months in Sikkim in 1906. After his retirement in 1931 he visited the Andamans and Australia. He published a second edition of his book in 1932, with three new genera and 161 new species and subspecies of Hesperiidae and 52 new species and subspecies of other families. Since that time he worked daily at the British Museum (Natural History) as an Honorary Associate, devoting himself to Hesperiidae of the World. The volumes are all entitled Catalogue of the Hesperiidae in the British Museum (Natural History), but they include species or subspecies of which there are no examples in the Museum. The first dealt with Africa and was published in 1937. The next in 1949 was on those of Europe, Asia, and Australia. Four volumes followed between 1952 and 1955 upon those of North and South America. He found the American material to be the most difficult as so many insects existed indistinguishable in appearance but differing in genitalia. Only the volume on those of Europe, Asia, and Australia is familiar to the writer, who has used it constantly for identification of Indian species. The magnitude of the work is astonishing. The particular volume is 502 pages, packed with information conveyed in the most economical form as descriptions are reduced to a few words showing the salient points distinguishing each subspecies. The work is in fact a huge key, compiled with meticulous accuracy.

Drawings of the genitalia of every species, and where necessary of subspecies, are placed in an appendix, so that an unknown male can be identified by dissection, the exact subspecies being ascertainable by its geographical range recorded in the key and by the short description of its particular markings. His ability in construction of a key to genera, always the most difficult task as it should cover females as well as males, can be appreciated by a comparison of the one made in this volume with that of his key in 1932 in his Identification of Indian Butterflies; the advance was made possible only by years of study. The secret of such a vast accomplishment was his skill in dissecting by the application of wood naptha to the genitalia and extraction of them and sticking on a card or by mere inspection without removal. He could do a complete dissection in two minutes and must have done many thousands. He has shown to the writer boxes full of set specimens, all of which he had dissected while engaged on some particular problem.

It must be remembered that his work covered Europe, where many experts had laboured and his decisions had to be exposed to critical examination by them, not always to their satisfaction as he reduced large numbers of names to synonyms. Many new species and subspecies were discovered by him in course of the work. For the single volume on Europe, Asia, and Australia he had to deal with over 75,000 specimens and with 1,065 types of species and subspecies in the Museum out of the 1,641 active specific and subspecific names for the area.

In his last years, between the age of 77 and 80, he published a paper in the BNHS *Journal* correcting mistakes in the Lycaenid genus *Lycaenopsis*. Another article in *The Entomologist* in 1954 was a revision of the genus *Curetis*, based on genitalia and an examination of the facies of 4,000 specimens.

One new species was found in South India, one in South Burma and SE. Asia, and another in Tonkin, and a new subspecies in the Naga Hills, Assam. In 1955 he published another article on the genus *Tarucus*, hitherto so confused, and produced a firm basis for the species based on genitalia but with a key that allowed identification by facies. Only those who have used it can know what difficulties it solved. A revision of the *Arhopala* of Asia is now in the hands of the printers. With lungs which never fully recovered from a German gas attack in France, with an unhealed phlebitis in a leg which gave constant pain and made walking difficult, and with a heart that did not allow him to climb stairs, he yet somehow managed to get to the Museum every day, doing original work that required great concentration of mind, keenness of vision, and steadiness of hand, ever ready to put aside his work and to welcome anyone who came to him with a butterfly for identification. He delighted to talk of old days in India and his happy wanderings in the villages, where he was received with such kindness and courtesy. A great entomologist and a great man has passed away.

K.C.

REVIEWS

1. FEATURES OF EVOLUTION IN THE FLOWERING PLANTS. By Ronald Good. Pp. xv + 405 (21.5 × 14 cm.); 162 illustrations by Marjorie E. Malins and the author. London, 1956. Longmans, Green & Co. 30*s*. net.

This book will certainly gladden the heart of many a botanist; it is a contribution to the literature on Evolution taken in a rather wider sense than is usual. The author draws the attention of all biologists to the lack of balance in our approach to evolutionary problems, and points out that this is the result of the general neglect of the evidence shown by the Plant Kingdom; in the author's opinion, we are greatly in need of reorientation in our ideas on the subject.

The first chapter deals with the critical evaluation of some of the points usually proffered as evidence for Evolution. The second chapter draws a comparison between plants and animals, and shows that little account has been made of the evidence supplied by plants, in spite of their close relationship with animals, in the past our ideas about evolution have been based almost exclusively on the study of the Animal Kingdom. In successive chapters the author reviews the whole group of Flowering Plants with reference to evolutionary problems. This is more clearly explained in some chapters where particular families are studied in detail.

The last chapter gives the summary of the author's conclusions. He has some interesting remarks to make, such as the following: 'Little or nothing in this picture of evolution in the Flowering Plants supports the view that they are the product of any highly competitive and eliminative plan of nature. On the contrary, it suggests that nature is expansive rather than contractile and no matter what new characters or new combinations of old characters change with time may present they are all able to find an existence somewhere in the scheme of things.'

Surely one would at once ask: 'How, then, to account for extinct forms of life?' Although the author has provided no direct answer to this question, he has drawn our attention to the many drawbacks of the evidence supplied by fossils, which constitute one of the most important points in support of Evolution in a limited sense.

The printing is excellent, and the illustrations 'made under conditions far from ideal' make a notable contribution to the high standard of the book. There are 162 illustrations, of which the greater number show individual species; 4 illustrations are rather striking, as they represent the development of Monocotyledons and Dicotyledons in a novel fashion.

Of late the interest of biologists in problems of evolution is growing deeper every day; the influence of personalities is slowly fading away in face of the accumulation of new and significant facts; the values attached to the various arguments in support of Evolution are changing constantly, and the change is a welcome one. The author has made a good attempt at bringing together some of the important points of evidence from the study of Flowering Plants, and his facts are reliable. In this reviewer's opinion the book will definitely stimulate the interest of all biologists, and particularly of botanists, in the study of the problem of Evolution.

P. V. BOLE

2. THE SHERPA AND THE SNOWMAN. By Charles Stonor. Pp. xii + 209 (8¼″ × 5″), 37 plates. London, 1955. Hollis and Carter. 18*s*. net.

The author was biologist and anthropologist to the *Daily Mail* Expedition in search of the Snowman. On pages 594-598 of Vol. 52 of this journal the editors reviewed the evidence available for the belief in the existence of the Snowman, but did not express any opinion.

The present accounts of the Snowman, picked up here and there as the author progressed into suitable country, are well reported. They appear to point to a bipedal creature about the size and build of a small man, and with a loud high-pitched cry which has apparently been heard by many. If it were not already known that the expedition was unsuccessful in its special quest, the interest in these reports would perhaps have been more sustained; as it is, and in the absence of any tangible fresh evidence, their reading is never very convincing.

The Tibetans apparently know of two species of *Teh*: *Dzu-Teh* and *Min-Teh*. The *Dzu-Teh*, which is larger, quadrupedal, and carnivorous, is similar to the Black Bear except 'for its size, colour and habits', while the latter is the *Yeti* or Snowman. The differences in size and habits are not mentioned but their descriptions otherwise appear to be similar.

The *Yeti* reported to be kept in the zoo at Shigatse (*JBNHS*, 52: 597) is now identified as a gibbon! The wide range of animals which can, and are made to, fit the descriptions of the *Yeti* makes one wonder if it really has any constant characters! However, so long as these legends and local descriptions persist, it is impossible to prove definitely that such a creature does *not* exist. We have just seen press reports of yet another expedition setting forth for the same purpose, this time equipped with a helicopter and blood-hounds! It will certainly be long before this mystery is settled one way or the other.

'The Sherpa and the Snowman' is well written and makes interesting reading. In spite of one's personal opinions and doubts one cannot resist the forlorn hope that such interesting creatures still remain to be discovered.

H.A.

3. BIRDS OF CEYLON, 3. By W. W. A. Phillips, F.L.S., M.B.O.U., F.Z.S. Pp. 50 (7½″ × 5″), 2 maps, 5 photographs by author, 20 coloured plates by Cicely Lushington. Colombo 1955. The Associated Newspapers of Ceylon Ltd. Price Rs. 5.

The present slim volume is No. 3 in this useful series of booklets of which the first two have already been noticed in the *Journal* [49 (3): 534, 51 (3): 708]. It deals with the birds of the Central Hill Zone or Highland Zone, which is perhaps of the greatest interest for the ornithologist since it contains most of the forms endemic to the island, or relics of the invasions (or 'waves') it received during its periodic connections with the Indian mainland in the geological past. The author points out that of the 397 species and subspecies of birds found in Ceylon 22 are confined only to the Hill Zone, while altogether 133 different birds may be met with in the Nuwara Eliya District and the higher hills. From these last, 20 species have been selected as likely to be of the greatest interest to the reader. As in the two previous booklets the text begins by pinpointing the leading clues for identification in the coloured plate on the facing page. Then follows a short account of the bird's habits, distribution (local insular as well as overall), and nesting. The book ends with a chapter on Bird Migration in relation to Ceylon and gives a useful map of the assumed main migratory routes to the island. The coloured plates are well drawn and well reproduced.

Mr. Phillips, who has now retired to settle in the U.K., has made himself deservedly immortal in Ceylon by his thoroughgoing field studies and writings on the island's natural history, particularly its mammals and birds.

S.A.

4. AN INTRODUCTION TO THE BOTANY OF TROPICAL CROPS. By Leslie S. Cobley. Pp. 357 (8½″ × 5½″), 82 plates. Line drawings. London, 1956. (Longmans, Green & Co.) Price 37*s*. 6*d*.

It has been a pleasure to run through 'The Botany of Crops' which is a masterly abstract of a vast subject, in a very businesslike form. Even in this book over four hundred crop plants have been described, and that in less than 350 pages. Of course, quite a large number of crops have had to be omitted. For my part, I would have preferred a larger number being omitted, but the fewer treated in greater detail.

The book is excellently got up and I am glad the author has divided the plants not according to natural orders, but rather according to the use to which the produce is going to be put: cereals, fibres, oilseeds, pulses, root crops, spices, beverages, drugs, fruits, vegetables, rubber, essential oils, and sugarcane. This is far more useful to an agricultural student than arrangement by natural orders. The two indexes meet the needs of the student excellently.

A very good feature of the book is the excellent drawings and photographs. These give a clear idea of what the author has described. Although the scale of size is given in places, in others it is not. The usefulness of the drawings is greatly increased by the mention of the scale and I wish it had been given for every drawing.

The descriptions are extremely lucid and give one a clear picture of the plant or flowers described. This is achieved in spite of the fact that the descriptions are very brief. At the end of each section is a list of reference books. From these lists, it is evident the author is not familiar with Indian literature on the subject.

The brevity adopted throughout has affected the accuracy of certain statements. Regarding bananas, it says, 'will grow in a variety of soil types wherever rainfall is spread evenly throughout the year and wherever the temperature does not fall below 50° F.' This and similar statements are inaccurate, as bananas grow quite well in areas where rainfall is small and limited to three months in a year, as also where temperatures fall considerably below 50° F. Take again the following in regard to turmeric: 'It requires a hot, moist climate'. Turmeric cultivation is carried on in India in some of the areas with very dry climate, and there very successfully. Under 'Sugarcane' the author says 'an annual rainfall of at least 60″ is required'. Now we have areas in India with rainfall of only 20″ which produce bumper crops of sugarcane. One more inaccuracy must be mentioned: the book states that the Indian varieties of mangoes contain only one embryo. This is incorrect for there are polyembryonic varieties also, and many that ordinarily produce one but occasionally more embryos.

When all this is said and done, inaccuracies of this kind are not found on the side of descriptions of plants, flowers, and fruits. These latter are very accurate and clear. I have no hesitation in saying that this work is a most valuable addition to the literature on the subject and as a book of reference for students of tropical botany and agriculture.

J. A. ALI

5. OPEN AIR GUIDES—BARK. By Dr. Alfred Schwankl. Translated and edited by H. K. Edlin. Pp. 100 (20.5 × 13.5 cm.). With 156 illustrations of which a few diagrammatic, the rest photographic. Thames and Hudson, London—New York, 1956. Price 12*s*. 6*d*.

This handy manual is highly recommended by its presentation, which is of the highest quality; the photographs and their reproduction are excellent; the text is simple and without technical terms. The text has been accommodated to forest trees of Britain. When reading the text and admiring the magnificent photographs, I feel not a little envious. A similar book for India would serve a very useful purpose.

The book consists of three parts of rather unequal length, but all of excellent quality. Part One deals with the bark of trees at various stages of their growth, the differences between healthy and diseased trees as shown by the bark, etc. Part Two is the longest, and gives details of the bark of seventy-five different trees and woody shrubs.

Part Three is a study of the component parts of bark and the various uses to which bark can be put. All these points are explained with great lucidity, and illustrated with equally good photographs.

The author states in the introduction that 'the bark reveals the tree, and is the outward expression of its inner character . . . Further, each kind of tree may be identified by the form and colour of its bark . . . This book about bark is addressed both to nature lovers and also to those professionally concerned with tree bark, whether as foresters or timber merchants . . .'

In my frequent rambles through the forests of India, I have come to recognise many of the more important tree constituents of our forests from the colour or structure of their bark; some of our trees have such a clear and definite structure and colour that the tree can at once be identified merely from the bark, even when leaves, flowers or fruits are absent. A similar book on our forest trees would be a great boon, particularly for those forest officers who are not particularly strong in systematic botany. The book under review shows what can be done in this line; but a book on our Indian trees will require both a good photographer and an even better printer. The present book is printed throughout on art paper, on which the photographs show even the minutest detail.

The standard of presentation is of the best and does honour to the British printing industry. I have no hesitation in recommending this book to nature lovers and to keen photographers. In view of the number of illustrations and of the quality of the paper, the price of 12*s*. 6*d*. is very moderate; and this is another good reason for recommending this book to interested readers.

H. SANTAPAU

6. LIST OF INDIAN FUNGI—1952-1956. By C. V. Subramanian and K. Ramakrishnan, University Botany Laboratory, Madras-5. (A separate reprint from the Journal of Madras University, B, 26 (2): 327-421, 1956; no price indicated.)

This is an excellent List, in which all the new Fungi discovered in India during the years 1952 to 1956 have been given with full references to the original journal in which the Fungi were described, and the hosts and places where the various items were discovered.

The list is an impressive one, as it enumerates not less than 765 new species or genera or new records; many of the new organisms have been discovered by the authors themselves, but the list is not restricted to their own discoveries. As a complement to this List, the authors give several appendices of interest; one is of references to the literature, in which 307 items are given in alphabetical order of authors' names; the references are fully in accordance with Appendix VI of the International Code of Botanical Nomenclature, and in a style that is uniform and clear. Appendix 3 gives 'List of Hosts and Substrata', and Appendix 4, 'Systematic Arrangement of Genera'; these appendices add greatly to the value of the paper.

The presentation and printing is good; to judge from the present specimen, the Journal of the University of Madras is considerably ahead of most of the journals of our Indian Universities.

H. SANTAPAU

7. BUTTERFLIES OF THE INDIAN REGION. By M. A. Wynter-Blyth. Pp. xx+523 (10″×7″). With 27 coloured and 45 black-and-white plates. Bombay, 1957. Bombay Natural History Society. Price Rs. 28.

Mr. Wynter-Blyth's book has come as a pleasant surprise to me. I had been led to expect a 'Popular' book, which is usually of equally little use either to the specialist or the enthusiastic amateur, but the Society has produced a publication which will occupy a permanent place in Indian Natural History, akin to Whistler's 'Popular Handbook of Indian Birds'. It is the book for all grades of collectors excepting the specialist, but *par excellence* for the general natural historian or the beginners, who wish to know something about the butterfly fauna of their country without recourse to pages of small-print descriptions or keys of the genitalia. It represents the type of Natural History book which has become so popular since the war in Britain and United States, combining much scientific information in simple language with descriptions of most of the species likely to be found by the ordinary person.

There are four aspects of this book which are a particular joy. In the first place it is very complete as far as those species are concerned which are really rare but which by their geographical distribution are not impossible for the ordinary collector to find. Secondly, the cover given to species in Eastern India is excellent. Time after time one has been driven to despair by books which seem to forget that Assam is included in the Indian region, but Mr. Wynter-Blyth has avoided this pitfall. Considering that Assam has the most numerous, interesting, and spectacular butterfly fauna in India, not to mention a considerable proportion of the total number of collectors, this is an important recommendation. Thirdly, a new and welcome feature for the beginner is a key to the commonest butterflies. And lastly, the general and introductory sections are excellent and could hardly be bettered, giving a great deal of information in a readable form.

I am so filled with admiration at the enormous amount of work entailed in preparing a book of this nature that it seems ungenerous to be critical. This especially applies to a group such as the Lycaenids, but I feel, nevertheless, that a few more keys here would have been of the greatest help. The illustrations are profuse (72 plates, of which 27 are in colour and 7 figures), greatly adding to the value of the book and making it the more remarkable that it has been possible to keep the cost as low as Rs. 28.

T.N.

MISCELLANEOUS NOTES

1. FOOTPRINTS OF 'SNOWMAN'

I was on the fourth trip to Rupkund on September 16, 1956, and was camping in the rock-shelter of Baguva-vasa, 3½ miles before reaching Rupkund. It began to snow from 2.30 p.m. with terrific thunder-claps at intervals, and fine hail bigger than mustard seed fell. By 5 p.m. the snowfall stopped; the sky became completely clear by 6 p.m. and there was bright moonlight. The depth of snow was 4 to 6 in. in front of the rock-shelter, but it was less towards Balpa-Sulera, a hundred yards on the east of Baguva-vasa and on the windward side.

On September 17, 1956 at about 4 a.m. the whole region was enveloped in thick mist; at 4.30 a.m. it began to snow intermittently; at about 9 a.m. there was a hailstorm for about 15 minutes. Thereafter the sky began to clear up, and the sun could be seen shining on the neighbouring hilltops, but there was mist still here and there though Rupkund was seen clearly.

Leaving the luggage in the rock-shelter, I started with my two porters at 10 a.m. towards Rupkund. We had hardly proceeded a hundred yards to the place called Balpa-Sulera, with Nanda Ghunti, Trisul, and Chananiya Kot peaks, and Rupkund in front of us, when I suddenly saw some footprints on the ground. Casually I enquired of my porters if there were any panthers or hyenas in that region; they said that there were 'lakad-baggha'. On a close examination of the footprints, after removing my goggles, I found them to be like those of a human being. The elderly porter immediately burst out: 'Footprints of Chananiyas, the doliyas or palanquin-bearers of Nanda Bhagavati'.

The trail of footprints was seen coming from the direction of Rupkund and going towards the ruins of Balpa-Sulera, and then up over the Baguva-vasa rock-shelter. I could not follow the trail, since the animal had travelled over a steep track from one rock to another, and since the footprints were not in one plane. The footprints measured 5¾″ × 2¾″ and one to two inches in depth, on fresh snow. The impressions were quite clear and fresh with all the five toes and heel distinctly seen; black spots of bare ground could also be seen in some footprints. They were just like those of a human boy. The animal must have passed that way after the fall of the last hail before the mist cleared at 9 a.m., since there could not be seen any hailstones in the footprints, whereas small pearl-like hail was lying about on the surrounding snow. So, the animal must have passed that way at the most an hour before I saw its footprints. At places there were three, or rather 2½ footprints; and so the animal must have been on all fours, at least at those places. Unfortunately I could not pursue the trail for more than 50 yards on either side, first because the trail led up a steep ascent and secondly because the porters were in great haste and fear as it had begun to snow again at about

10.45 a.m. Reluctantly I had to return to Wan, giving up all chances of a fuller investigation.

I am of opinion that the footprints I saw could well be those of a baby Brown Bear, which might have come down from Rupkund side or Gingtoli plain. It had snowed heavily on the previous day as well as the following morning and the whole slope from Kailva-vinaik to Rupkund was one continuous white sheet. The animal might have come down this slope in search of food. If not a Brown Bear it may have been an ordinary Black Bear from the near-by jungles, which are situated within a radius of four miles on all sides.

It may be mentioned in this connection that in the year 1905 Lord Curzon, Viceroy of India, visited Jetha Kharik, 1½ miles east of Ali Khal and about 6 miles from Baguva-vasa (where I found the footprints), for shooting brown bear. A road was specially constructed at that time from Wan to Ali Khal, which still exists and which has been repaired by Shramadan. So it would not be surprising for the footprints I noticed near Balpa-Sulera, at a height of about 14,000 ft. above sea level, to be those of a brown bear cup, with its mother sitting somewhere near by; or perhaps even of a black bear, which is very common in the neighbouring jungles. I came across a solitary male bharal near Chedi-nag midway between Baguva-vasa and Rupkund on August 25, 1956, on my first trip to Rupkund.

When I was on my fifth trip to Rupkund, on October 7, 1956, I came across a trail of footprints, a little beyond Patar-Nachauniya (about a mile before reaching Baguva-vasa), which were round at one end and tapering at the other. They were 4 in. long, 3 in. wide, and ⅞ in. deep. They were found on snow which had fallen four or five days previously. The upper part of the snow was encrusted so hard that my feet were not sinking in it at all but were skidding at several places. Several of the footprints were found in the middle of human footprints, that were left two days previously by an advance party who had gone up to Baguva-vasa. On enquiry from the elderly people of Wan village I was told that the footprints might be those of a tharuva (Snow Leopard) or a lakad-baggha (hyena).

Some villagers of Wan reported that the footprints of Chananiya (footprints like those of human beings) were noted occasionally in winter at Bagchho and Kukin Khal (3½ and 8 miles respectively from Baguva-vasa). So the strange footprints of the so-called snowman are apparently known in the Rupkund region from long years, though the villagers do not suspect them to belong to a bear. They believe them to be those of Chananiyas, whose abode is said to be the peak Chananiya Kot, situated on the northern side of Rupkund.

In the paragana of Danpur of Almora District and in Badhan and adjoining paraganas of Garhwal District, Chananiya is a Vana Devata or deity of the forests. She is said to have the feet reversed, i.e. toes pointing backward and heel in front. So, this deity is also called Ediya (heeled one). When lone women go to the jungle for cutting grass they are said to be frightened and affected by the evil influences of this deity. To get rid of these evil effects, the afflicted persons propitiate this deity. So far as my knowledge goes, there are two shrines dedicated to this deity, called Ediyaka Than—one between Gwaldam and Garur in Almora District, and the other near about Karnaprayag in Garhwal District.

Langurs or Blackfaced Monkeys are very timid and I never heard of one biting a man, excepting perhaps at Jagannath where they are fed freely by pilgrims and where they often become bold enough to snatch away food from their hands. No doubt Redfaced Monkeys attack man and even bite, assault, and injure very badly. I have never seen the Blackfaced Monkeys beyond the tree line or at heights above 10,000 feet; as such there seems absolutely no possibility whatsoever of either the Redfaced Monkey or the Blackfaced Langur having left the footprints at Baguva-vasa, which is at an altitude of 14,000 ft. Besides, the footprints of a langur monkey are in fours, quite different and distinct from human footprints. The footprints I saw were just like those of a human being. Monkeys and langurs do not go beyond Wan and Sutol in the Rupkund region.

I would be much obliged if any of your readers could tell us the height and place in the Himalayas, and the year, in which the two Norwegian engineers Age Thorberg and Jan Frostis had an encounter with the two langur-like animals, one of which is alleged to have bitten Forstis.

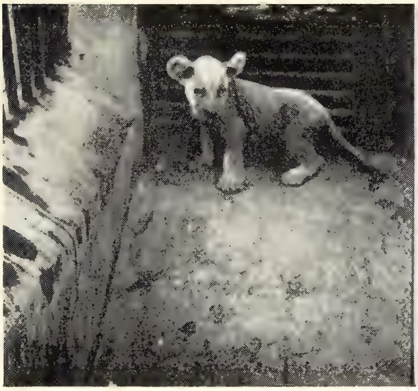
Almora, U.P., SWAMI PRANAVANANDA, F.R.G.S.
November 6, 1956.

2. HAIRLESS LION CUBS IN THE TRICHUR ZOO

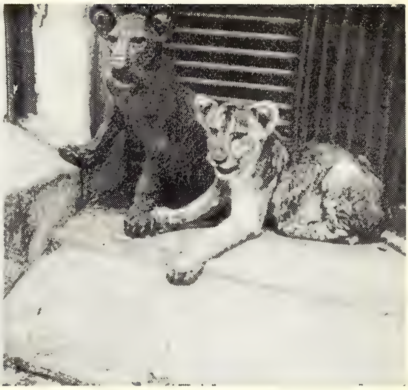
(*With a plate*)

At the first meeting of the Zoo Wing of the Indian Board for Wild Life, held at Mysore in last May, I had occasion to point out the existence of a litter of three lion cubs in the Trichur Zoo, of which the two males are practically hairless while the single female is covered with hair and normal in every respect. They were born on March 6, 1955 and during growth even the scanty hair the males had was shed, developing at the same time a tendency to accumulate dark pigment in the skin, probably as a protection against excessive heat. The entire skin is now somewhat rugose, the rugosity being more marked on the head and neck. The few hairs still left are confined to the chin and the inside of the ear lobes. The absence of hair on the body is certainly a handicap to the two cubs, causing abrasions in the skin especially at the haunches, where even small callosities have been formed. The present condition of the lion cubs looks like alopecia with a tendency to melanism.

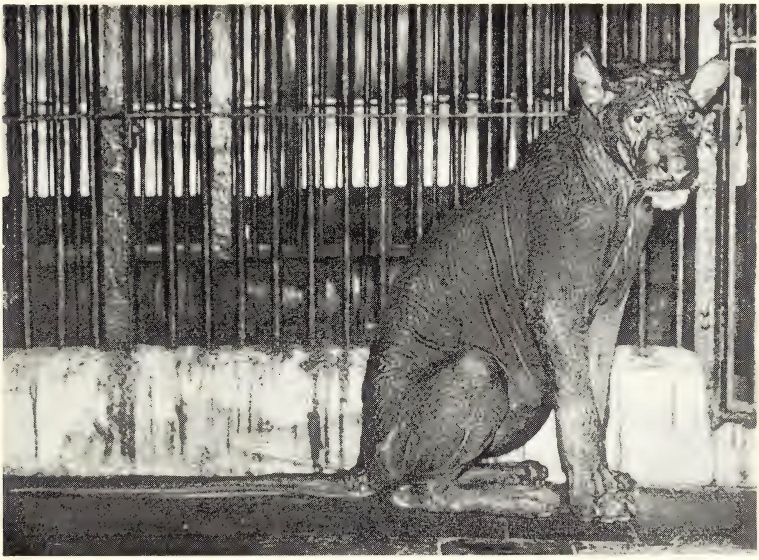
Being the first instance of its kind in this Zoo, where lions have been breeding in captivity for over thirty years, the deficiency could not be traced to any known cause. On the advice of the local veterinary surgeon, Murnil, a preparation of Bayer with vitamin H, was given to the cubs continuously for several months but without any effect on the growth of hair. All the three cubs have normal health and have grown remarkably well with their usual ration of mutton and beef.



Male lion cub, 3 months old, before shedding the sparse coat of hair



Lion cubs, hairless male and normal female, six months old



Hairless lion cub, male, about twelve months old

Photos : M. Govindankutty Menon

In the previous litter of triplets born of the same parents on August 8, 1954, that is just over six months back, all the cubs were normal. That littering, however, took twenty-four hours to complete, with an exceptionally large cub coming as the third in the series.

The long interval between the birth of the first two cubs and the third one not only resulted in the still birth of the latter, but complete neglect of the two first-born cubs causing their deaths in turn. But, apart from their accidental deaths, the cubs themselves were perfectly normal.

No doubt the absence of hair in the two male cubs of the second litter of this lioness can be attributed only to some developmental deficiency caused probably due to malnutrition during the period of gestation. Even so, it is interesting to note that the female of the same litter is completely free from this congenital defect. Tracing the ancestry of the parents it is found that nothing abnormal has been noticed at any time and it remains to be seen how the hairless condition of the two male cubs will behave in subsequent generations. The only departure followed in the breeding method in the present case is that the male and female were allowed to pair in less than three months after the first parturition. This, of course, would not have happened if the cubs born of the first litter were alive.

THE STATE MUSEUM AND ZOO,
TRICHUR, M. GOVINDANKUTTY MENON, M.A.
August 29, 1956.

Dr. W. C. Osman Hill, Prosector of the Zoological Society of London, has kindly sent us the following memorandum on the subject:

'The appearance of what seems to be a 'sport' in a litter of lion cubs strongly suggests that the hairless state has arisen by gene-mutation. The fact that only the males are affected is presumptive of sex-linkage, but further breeding, which it is to be hoped will follow, should settle this point, as well as others relating to the genetic behaviour of this curious allele.

'Total alopecia of congenital origin (atrichy) is known so far in mice (both wild and domesticated) and dogs (especially the now well-known Mexican hairless breed). It has also been reported in horses and in a shrew (see Bateson, 1894, and references there cited). The lack of hair is commonly associated with other (? compensatory) dermal changes, notably increased pigmentation, thickening and a tendency to transverse wrinkling, or warty developments. Sometimes the teeth are defective, e.g. in hairless dogs (Yarrel, 1833; Jerina, 1920, quoted by Danforth, 1925).

'Once present the condition is heritable, hence the feasibility of producing the 'pure lines' in dogs. Unfortunately, little is known of the genetics of atrichy. Winge (1950) makes the rather ambiguous statement that it may either be dominant or recessive, though when dominant does not seem to be especially 'weakening'.

'That dietetic or metabolic effects upon the pregnant female are responsible is ruled out in the present instance by the normal condition of the female member of the litter. But it might be mentioned that Jerina reports experimentally produced alopecia totalis in rats by feeding thallium acetate to the pregnant and nursing mothers.

'The bald condition of the Naked Mole-rat (*Heterocephalus glaber*) is of a different nature being, in all probability, due to phylogenetic retardation whereby the newborn condition persists until adult life, an explanation which also accounts for the relatively glabrous skin in man. This retardation (neoteny) is itself determined by a mutation affecting the behaviour of certain ductless glands whose activities control the growth processes.'

REFERENCES

Bateson, W. (1894): *Materials for the study of variation*, London, Macmillan, p. 56.

Danforth, C. H. (1925): *Hair, with special reference to hypertrichosis*, Chicago, Amer. Medical Association.

Jerina, F. (1920): *Studien über die Haararmut und Haarlosigkeit bei Haustieren*, Inaugural Dissertation, Bern. (quoted by Danforth).

Winge, O. (1950): *Inheritance in dogs, with special reference to hunting breeds*, translated from the Danish by Catherine Roberts, Ithaca, Comstock.

Yarrel, W. (1833): Exhibition of Egyptian hairless dog, *Proc. Zool. Soc. Lond.* 1833, p. 113.

Writing on 19-2-1957, Mr. Menon adds:

'The mother of the cubs littered again on 1-11-1956 having paired with the same male. The two cubs (one male, one female) born now are quite normal. The hairless male cubs of the last litter have grown quite as well as the female cub. There is a tendency for the two male cubs to go together and also lie close to each other. They are also rather timid compared to the female. The teeth and claws of the two males, originally not quite so well developed as those of the female, are now more or less of the same size and strength. In addition to the pigmentation, warty growths are also noted on the skin of the hairless cubs.'—EDS.

3. 'SCENT TRAILS' AND 'POOKING' IN TIGER

In the *Journal* of December 1956, the reviewer of 'The Tigers of Trengganu' has touched upon some interesting matters that must have caught the particular attention of many other readers of that very interesting book. And here I should like to discuss the statement therein that the Malayan tiger ejects a strong smelling secretion from the root of the tail, and then to introduce certain other matters, not irrelevant to tigers in general, in order to invite the interest of other sportsmen who have carried an enquiring mind in their pursuit of the tiger.

Once while watching a zoo tigress pacing her cage, I observed that almost every time she turned away from one side of it, to resume her walk to the opposite side, she squirted a jet of urine at the bars, and simultaneously uttered what I shall here allude to as the 'pook'—but uttered more softly than it probably is in other circumstances. And, immediately preceding the 'pook', there was a sound like a short, suppressed hiccup, which in after years took my mind to the Burmese version of the sound as the 'tit', or titting of a tiger (though I myself had never heard it there); those who have had any acquaintance with that language will know how our Burmese friends pronounce the 't' at the end of such a syllable; and if I have chosen to imply that the utterance of it resembles a hiccup, it is chiefly because I noted that when that zoo tigress uttered that double sound (*hic-conk*; though the second one was more of a high-pitched *kink*) there was a slight spasmodic contraction of the belly and, with the *hic* or *tit,* the head was dipped momentarily with the neck slightly arched, while the cheek muscles retracted the corners of the lips at the same time.

The tigress did not utter the 'pook' every time she ejected urine, nor vice versa, the 'pooks' being uttered usually during her walks to opposite sides of the cage. In the act of squirting urine the vulva briefly opened as those of mares do, and the tail was rigidly flirted upwards; and I seem to remember that this movement of the tail always accompanied the 'pook' too. From these signs I formed the opinion that the tigress was in season.

The urine—a short jet—was squirted slightly upwards, at an angle of perhaps 15 degrees above the horizontal; and being propelled at a velocity sufficient to carry it about 10 ft. or more, this jet of urine was barely visible to anyone standing a few yards away from that large cage, especially as the jet broke into a fine spray towards the end of its trajectory. It was when I moved to the rear of the tigress as she walked away that my clothes received some of that spray; and the pungent odour of it was similar to that which I have sometimes detected in the jungle and ascribed to the proximity, or recent presence, of a tiger. Indeed, I once detected this odour a few seconds before a wounded tigress began 'caterwauling' in a thicket about 50 yards away (a cry discussed in the Bombay Natural History Society's journal many years ago). I cannot, however, remember having noticed this odour at tiger- or panther-'scrapes' which I have examined in the jungle; nor have I detected it on a dead animal, tiger or panther. If, as the author of 'Tigers of Trengannu' seems to suggest, the odour is derived from scent-glands at the root of the tail, I must admit that I have not yet discovered such glands there on a dead animal, perhaps because I had not looked for them?

Some amongst the jungle tribes that I have hunted with have assured me that even male tigers can, and do, spray tree-trunks and high bushes with their urine.

On a few occasions in Indian jungles I have believed I had heard a tiger 'pooking'; but, as the sound was said to resemble the 'conk' of a sambar, I was never certain of having correctly identified it. On two later occasions, however, a couple of years ago and when camped in the lower Nilgiris, I did recognize the sound with certainty. For on both occasions it was uttered from quite a short distance off, and was preceded by the *hic* I have described, faint but quite distinct from the *conk* that followed. Besides, on the evening of the first occasion a tiger had killed a cow less than a furlong from where I was, and actually while the herdsman was calling the cattle to the pen; on the following evening a man had run in to say that the tiger was behind him and on its way to the kill. It was about 10 p.m. when I heard the 'pooking' for the second time (and I wonder why the sound has become so widely accepted as a *pook* when it is more like the sambar's *conk*—even the Burmese *tit* is phonetically a more apt description !).

RATNA COTTAGE,
FERNHILL (NILGIRIS),
January 22, 1957.

K. BOSWELL,
(*Capt.*)

4. FOLLOWING UP WOUNDED TIGER AT NIGHT

Lt.-Col. A. Locke, the author of the recent book 'The Tigers of Trengganu', apparently believes in following up a tiger immediately after wounding it, even at night. I once read about a well-known professional hunter in French Indo-China, a man with a French name (was it de Fosse?) who preferred to follow up at night because, as he pointed out, the wounded animal was then the more readily spotted by its eyes reflecting the light of an electric torch, and he insisted that this was therefore the safer method. And, considering the matter objectively and quite impersonally, it would at first appear that he was right, that his was the saner method, as seeing the animal before it charges certainly reduces the odds, even in daylight; and it must be assumed that the torch used for the follow up at night must have a wide, diffused beam of light, and that not too many torches in the hands of others would be used, for their effects would be bewildering. But, and I would suggest that this is the crux of the matter, before the animal's eyes may be picked up with the torch its trail must be followed. Can this be done as well by artificial light as by daylight? I think not. My torch has shown the blazing eyes of panthers (unwounded) at very close ranges, a tiger's too, and once at about 200 yards when they shone like small twin stars; but I have also known raindrops and dew, as well as bits of quartz, to reflect gleams that resembled the eyes of animals. And to follow up a wounded tiger at night, when human morale is naturally low (and is not a measure of confidence always important?), must require stark courage, for a task which is invariably the most frightful in the experience of a big game hunter. And can one be always certain of the torch revealing both eyes, to thus indicate the position of the head as a target for the first shot before a charge is launched, or before the animal can turn away? On one occasion a tiger, suspicious of my 'hide' on the ground which had not been there before the kill had been made, was finally revealed about 75 yards away by the diamond-bright gleam from one eye it was exposing at the side of a tree-trunk behind which it was sitting. On another occasion, while returning through scrub jungle from a point where I had hoped to ambush a panther whose usual route I knew, something prompted me to stop and flash my rifle-torch to the rear, and there in the beam was a single brilliant eye beside some dark object, probably a small boulder. On yet another occasion, with a Gond as companion, we were taking a short cut through scanty jungle. The Gond stopped. Getting his bearings, I thought, till I noticed him make a slight recoiling movement and saw his hand reach back towards me; and then there, crossing our front and perhaps only 15 yards away, was a tiger, ghostly gray in the moonlight but recognizable by its shape and gait. A few moments later I put up my rifle and switched on the torch, but the apparition instantly vanished; the few, bare, intervening twigs reflected back the light dazzlingly, so that nothing beyond the nearer ones could be seen. And who has not observed this effect from a single leaf or twig near the front of a torch? In such circumstances the most brilliant light has not sufficient 'depth of penetration' to aid the eye. And, similarly, I have seen the eyes of a tiger at about 20 yards almost blacked out by the reflection from a bunch of leaves above the beam from my torch. And, after all, how much of the body behind brilliantly blazing eyes is ever revealed by the torch? Even the outline of the head cannot be clearly discerned!

So, to my mind, to follow up a wounded tiger (or, especially, a panther) at night might well be a game which is not worth the great risk involved. And I think that the most difficult part of such an undertaking must lie in the preliminary following of the animal's tracks and other signs, including the recognition of any but a heavy blood-trail (torch directed at the *ground*!).

Nevertheless, it has been done successfully; and perhaps the physical condition of the wounded tiger had contributed to that. So one must suppose that a tremendous amount of luck entered into it too, and that the pitcher did not go too often to the well!

RATNA COTTAGE, K. BOSWELL,
FERNHILL (NILGIRIS), (*Capt.*)
January 22, 1957.

5. FURTHER NOTES ON THE HIMALAYAN MOUSE-HARE, OR PIKA, (*OCHOTONA RUFESCENS*)

Last year I collected several specimens of the Baluch Pika *Ochotona rufescens vulturna* Thomas[1] a subspecies of the Afghan Pika, from the Munna Valley (8,000 ft.) about ten miles west of Ziarat and about sixty miles north-west of Quetta.

The type specimens of the Afghan species described by Gray in 1842 were captured from Bagha-i-Babar, two miles south-west of Kabul in Afghanistan. I paid a number of visits to the Baber Gardens during my recent stay in Kabul, but in spite of careful search was unable to find any pika living there. The animal appears to have totally disappeared, owing probably to the reconstruction of the tomb of the great king and other alterations made in the Gardens during recent years. I did, however, notice the animal inhabiting the neighbourhood of the city (*JBNHS*, 45: 82), in the rocky hills of Tungi-a-Syyedan about nine miles south-west of Kabul. I also found it at Surchashma sixty miles south-west and, in August 1946, in Durra-i-Shaidan about a hundred and thirty miles north-west of that city. The Durra is a valley beyond Bamian (8,000 ft.) on the way to Bund-i-Amir in Hazārajaat. Further north it is stated (P.Z.S. 1848: 800) to occur in Grishk.

---

[1] According to Ellerman and Morrison-Scott (Checklist of Palaearctic Mammals: 453) *vulturna* is an aberrant form based on one specimen only (the type from Harboi, near Kelat, Baluchistan) and may not belong to the species *rufescens*.—EDS.

We find, among early records, Alexander Burns (Cabool, 1842, p. 163) saying: 'In Kohistan, the most active search is made for all animals which yield fur . . . There are eight or ten different species to be found here, amongst which are . . . and the Hazāra rat, which is a creature without a tail.' This tailless creature is doubtless an Afghan pika and it is evident from the statement that it also occurs in Kohistan, a province north-east of Kabul. The pika, as I was informed, is common in Hazārajaat, the central plateau of Afghanistan, and this seems to be correct because the two places mentioned above (Surchashma and Durra-i-Shaidan) lie on the borders of Hazārajaat. It is natural that the animal should be called in some districts '*Mūsh-i-Hazāra*' or the Hazāra rat. It is interesting to note that Alexander Burns was presented with the Hazāra rat as one of the fur-bearing animals having commercial importance!

In most species of small rodents a cycle of abundance alternating with scarcity is known to occur, but little is recorded about the Himalayan Mouse-Hare. I was able to observe the phenomenon in the case of the Surchashma pikas. In 1939, while walking along a rill on the hillside, I noticed a pika (for the first time in that country) sitting on a rock. I advanced stealthily and threw a stone at it, which accidentally killed the animal on the spot. Next year I attempted in vain to kill another animal in the same manner. But in 1941, I noticed that the numbers of the animal had greatly decreased and it was with much difficulty that I was able to obtain one. Unfortunately this too was badly damaged and bruised like the last specimen. When I visited the place again in 1942 I completely failed to notice the animal in spite of sufficient search, and it appeared to have totally vanished. On discussing the matter of its disappearance, some of the local cultivators told me that periodically the animals migrated to some distant place while others held that some sort of disease spread among them and decimated them. When I had another chance to visit the place in 1943 I found the animals there but was unable to procure a specimen myself. Consequently I sent word around offering a reward for each specimen whether alive or dead. Returning after two hours from a round along the adjoining hills, I was surprised to find myself surrounded by men, women, and children, some with wire traps, others with box traps, containing two, three, or even four pikas in each, while other villagers held the animals—one, two, or three together—by their ears or wrapped up within their garments. This scene as well as my own observations assured me that the animals were present in far greater abundance than in any of the previous years.

The villagers of the Munna Valley, however, seemed to be unacquainted with the cyclic fluctuation in the numbers of the animals, but the pikas were certainly present in large numbers this year. One would be peeping out of its hole among loose stones, another carrying straw, while another would be sitting on a rock on its haunches and sniffing the surrounding air as if to examine the environment. The inhabitants here have no idea of pulling the animal out of its hole by its ears as the Surchashma boys sometimes do; they usually shoot them. Almost every man possesses a matchlock to guard his family but, since cartridges are difficult to procure in these remote regions, the hunters carry with them a quantity of powder and a lead wire. Whenever required they load up with some powder, add pieces of lead cut from the wire, and shoot. In this way they shot several pikas for me. They are good marksmen and hardly ever miss.

During a talk the inhabitants complained of the pikas being a great menace to their cultivation. They remarked that some English people had introduced these creatures (which they call '*mushai*') into the country from some foreign land a century ago. As proof of this they added that certain Englishmen were used to visiting these parts very often in order to look after the animals and to ascertain their welfare!

West Regional Laboratories,
P.C.S.I.R., S. A. AKHTAR
Lahore,
December 10, 1956.

6. A NOTE ON INSECTS CONSUMED AS FOOD BY SQUIRRELS AND BIRDS AT KUNDRI FOREST, PALAMAU DISTRICT, BIHAR

With a view to ascertain the agencies responsible for a new type of damage to living lac cells observed at Kundri forest, Palamau District, Bihar, a large number of squirrels and birds found on the lac-bearing trees at the time of occurrence of the damage were shot and their stomach contents examined for the presence of lac insects. During the examination a large number of insects besides the lac insects were also encountered and this note records the species of insects consumed as food by these animals.

It is seen from the results that besides lac insects, termites, ants, grasshoppers, beetles, lepidopterous larvae and moths, bugs, wasps, lice, and mites were traced in the stomach contents.

Lac Insects: These are consumed freely by the common Five-striped Squirrel (*Funambulus pennanti* Wroughton) and to some extent by the Goldenbacked and Mahratta woodpeckers and the Redvented Bulbul. The number of each of these bird species was comparatively small in the area and they were found distributed throughout the forest; whereas the squirrels were more common and seen in greater concentration in the coupe that was under lac infection. Further, the fact that 23 squirrels out of the 36 examined contained lac insects ranging between 1 and 134 establishes beyond doubt that the squirrels are responsible for the huge destruction of lac insects at maturity of the lac crop in summer.

Termites: The mound-building termite species *Odontotermes obesus* (Rambur) which attacks *palas* trees (*Butea monosperma*) was

INSECTS CONSUMED AS FOOD BY SQUIRRELS AND BIRDS

Name of animal	No. of Stomachs Examined	Lac insect			Termite			Ant			Grass-hopper			Beetle			Lepidopterous larvae			Moth			Bug			Wasp			Louse			Mite		
		No. in which found	Range	Average	No. in which found	Range	Average	No. in which found	Range	Average	No. in which found	Range	Average	No. in which found	Range	Average	No. in which found	Range	Average	No. in which found	Range	Average	No. in which found	Range	Average	No. in which found	Range	Average	No. in which found	Range	Average	No. in which found	Range	Average
Squirrel ...	36	23	1-134	32·9	35	23-834	244	1	...	2	...	...	...	2	...	1	9	1-54	8·4	1	...	1	...	...	...	2	...	2	1	...	1	2	...	1
Goldenbacked Woodpecker...	10	4	1-11	6	3	6-609	279·3	5	12-340	98	...	...	...	1	...	1	...	...	...	...	...	...	1	...	4	...	...	...	...	...	...	...	...	...
Mahratta Woodpecker...	11	1	...	22	2	21-52	36·5	3	2-55	28·5	...	...	...	4	2-4	3	3	2-32	12	1	...	1	...	...	...	...	...	...	...	...	...	...	...	...
Redvented Bulbul...	5	1	...	5	1	...	10	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Coppersmith ...	3	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Indian Pitta ...	1	...	...	...	...	...	...	1	Few*		...	...	...	1	Few*		...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Wood Shrike ...	1	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Jungle Babbler.	1	...	...	...	1	...	...	...	...	...	1	...	1	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Small Minivet...	6	...	...	...	1	...	290	2	...	7	1	...	1	6	1-5	3	...	...	...	...	...	...	1	...	1	...	...	...	...	...	...	...	...	...
House Sparrow.	3	...	...	...	...	...	49	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Common Iora...	2	...	...	...	...	...	...	...	...	...	...	...	...	2	Few*		...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Rufousbacked Shrike...	3	...	...	...	...	...	...	...	...	...	3	1-2	1·6	1	...	2	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
King Crow ..	2	...	...	...	...	...	...	...	...	..	...	...	...	2	Some*		...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Common Weaver-bird...	1	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Common Myna.	2	...	...	...	...	...	...	2	...	7	1	...	2	1	Some*		...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Golden Oriole...	1	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Crow-Pheasant.	1	...	...	...	...	...	...	1	Some*		1	...	1	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...

* The terms 'Few' and 'Some' indicate a rough quantitative estimate, as the exact counts were not made.

found to have been taken in large numbers by 35 out of the 36 specimens of squirrels examined, as many as 834 being found in one specimen. All the forms of the termite colony except the Queen were found as stomach contents, of course the workers being in far larger numbers than the soldiers. This indicates that the squirrels play a not insignificant role in the natural control of termites. Among the birds, the two woodpeckers, the Redvented Bulbul, the Small Minivet, and the House Sparrow had consumed the termites in fair numbers.

Ants: Species of ants comprising *Camponotus compressus* and *Solenopsis geminata* were found in considerable numbers in the stomach contents of the two species of woodpeckers and to some extent of the Crow-Pheasant, Small Minivet, Indian Pitta and Common Myna. In one specimen of squirrel two ants were traced which might have been taken in accidentally.

Grasshoppers: Grasshoppers were found in the stomachs of the Jungle Babbler, Small Minivet, Rufousbacked Shrike, Common Myna, and the Crow-Pheasant. The grasshoppers being bigger in size must have been deliberately picked as food, although they were found in fewer numbers.

Beetles: Beetles were found in the stomachs of the squirrels, the two woodpeckers, Indian Pitta, Small Minivet, Common Iora, Rufousbacked Shrike, King Crow and the Common Myna. While they might have been consumed as food in the case of birds, their entry into the stomach of squirrels appears to be only accidental.

Larvae and Moths: The lepidopterous larvae were traced in fairly good numbers in nine specimens of squirrels and 3 of the Mahratta Woodpecker, suggesting that these larvae are deliberately sought after as food. A single specimen of an adult moth was seen in one squirrel and another in Mahratta Woodpecker.

Bugs: The bugs had been consumed in very small numbers by one specimen each of the Goldenbacked Woodpecker and the Small Minivet.

Other Insects and Mites: Wasps, lice, and mites were detected as stray items only in a few specimens of the squirrels, having been taken in accidentally.

Acknowledgement: The authors are grateful to Dr. S. V. Puntambekar, Director, Indian Lac Research Institute, for his keen interest in the work and for affording facilities, and to Dr. B. Biswas of the Zoological Survey of India for kindly identifying the squirrel and bird specimens.

INDIAN LAC RESEARCH INSTITUTE,
NAMKUM, RANCHI,
BIHAR,
November 20, 1956.

S. KRISHNASWAMI
N. S. CHOWHAN

7. TUSKS OF INDIAN ELEPHANTS

With reference to Mr. P. D. Stracey's note on the above subject in the *Journal* for August 1956 (Vol. 53, No. 4) I give below the measurements of two pairs of tusks of rogue elephants shot on the Baragur Hills in the Coimbatore District, Madras State, in 1926 and 1929.

1. Shot by R. C. Morris on March 2, 1926, at Kokkuvarai, Madeswaranmalai. Length of right tusk 7 ft. 4½ in. (weight 63 lb.); length of left tusk 7 ft. 7½ in. (weight 68 lb.).
2. Shot by Col. F. S. Gillespie and R. C. Morris on February 13, 1929, at Madeswaranmalai (Kokkurvari). Length of both tusks 8 ft. 2 in. (weight 90½ and 91 lb.).

It was remarkable that both these fine tuskers were shot in almost the same spot. The first elephant was undersized, due possibly to the fact that it had considerable difficulty in feeding itself, its tusks being crossed within about 18 inches of its mouth. The tusks of the second elephant were also crossed, but near the tips. Both were vicious rogues, attacking pilgrims proceeding to and from the famous Madeswaranmalai temple. The measurements were sent to and recorded by Rowland Ward and the Bombay Natural History Society.

C/O NATIONAL BANK OF INDIA LTD.,
26, BISHOPSGATE,
LONDON E.C. 2,
December 20, 1956.

R. C. MORRIS

8. HYPNOTIC BEHAVIOUR OF A WHITEHEADED BABBLER (*TURDOIDES STRIATUS*)

At 5.15 p.m. on the 17th of October 1955, hearing the clamour of a party of Whiteheaded Babblers, a pair of Magpie Robins, some striped squirrels, and crows, I went out to investigate and found our kitten crouching in front of a babbler which was less than a foot away from its nose. The babbler appeared to be dead. It had its bill, chin, and breast pressed to the ground; its wings were partly open and touched the ground; and the tail was thrust up vertically and awkwardly. The cat seemed to be waiting for the bird to make some slight movement before pouncing on it. There were 4 or 5 Jungle Crows on the trees close by ready to swoop down and carry away the babbler at the first chance but the cat refused to budge even after I had given it a kick. I turned away thinking that as the babbler was dead, and our cat had been off its feed for a few days, it would be better for all concerned to let the cat eat the bird if it wanted to. At the next moment there was a sudden uproar among the babblers that had assembled there, and I turned back expecting to see the cat walking away with the corpse. But, in fact, the 'dead' babbler had suddenly flown up into the mango tree and the cat was walking away mewing plaintively. The moment the babbler reached the tree, the others gave chase to it and, driving it from tree to tree, disappeared from the place.

I wonder if the cat could have 'hypnotised' the babbler; or was the bird merely paralysed or playing possum? It will be interesting to know whether instances of a similar nature have been observed by other bird-watchers.

GOVT. VICTORIA COLLEGE,
PALGHAT,
January 14, 1957.

K. K. NEELAKANTAN

9. DRUMMING OF THE MALABAR GOLDENBACKED WOODPECKER *BRACHYPTERNUS BENGHALENSIS*

Neither Whistler nor Sálim Ali say anything specific about whether this particular species of Woodpecker resorts to drumming. F. N. Betts, however, records [*JBNHS*, 37 (1)] that he has observed this species also drumming. Still it is apparent that the Goldenbacked Woodpecker drums much less often than some other members of the family, e.g. the Yellowfronted Pied Woodpecker (*Dryobates mahrattensis*).

In view of the comparative rarity of the performance the following observation might be of interest. On the evening of the 7th November, 1956, a male Goldenbacked Woodpecker (*Brachypternus benghalensis*) was seen to alight on a coco-nut tree at a height of about twelve feet from the ground. It moved round and round the trunk a few times, then pressed its beak on the trunk and produced the drumming note. Then it moved a few paces up and repeated the performance. After drumming a third time the bird flew away. Throughout, the bird did not produce its usual notes. The Woodpecker was not accompanied by its mate.

The note produced was a *Hur-r-r-r-r-r* sound, each time lasting for about two or three seconds. It was not particularly loud and could not have been audible beyond some twenty yards. The coco-nut tree is apparently in a healthy condition. I could not be certain whether the bird's head was vibrating when it was producing the note.

It would be helpful to have details from the readers of the *Journal* regarding which Indian species of woodpeckers are in the habit of drumming.

CHANDRAMANDIRAM,
PUTHUR,
PALGHAT,
December 13, 1956.

B. VIJAYARAGHAVAN

[Drumming has been recorded in the following species of Indian woodpeckers. Absence of specific records does not imply that other species do not drum, but merely points to the dearth of detailed field notes.. Additions to the list from observers will be welcome.

Large Black Woodpecker—*Dryocopus javensis.*
Andaman Black Woodpecker—*Dryocopus hodgei.*
Pigmy Woodpecker—*Picumnus innominatus.*
Yellowfronted Pied Woodpecker—*Dryobates mahrattensis.*

Indian Great Slaty Woodpecker—*Mulleripicus pulverulentus*.
Blacknaped Woodpecker—*Picus canus*.
Little Scalybellied Green Woodpecker—*Picus xanthopygeus*.
Goldenbacked Woodpecker—*Brachypternus benghalensis*.—Eds.]

10. ACCIDENTAL DEATH OF A CRIMSONBREASTED BARBET [*MEGALAIMA HAEMACEPHALA* (MÜLLER)]

In volume 39 of the *Journal* (p. 339) Sálim Ali writes that the Emerald Dove [*Chalcophaps indica* (Linn.)] sometimes meets with accidental death by getting dashed against whitewashed walls, in flight. He adds: 'The birds, flying as they do at great speed, no doubt take the sunlit patches of this wall (as seen through the dense surrounding shrubbery) to be the open sky and rush towards it with fatal results to themselves.'

At twelve noon on the 11th November, 1956, the body of a freshly dead Crimsonbreasted Barbet [*Megalaima haemacephala* (Müller)] was brought to me. I was told that the bird in flight dashed itself against a whitewashed wall of our house, fell down because of the impact, struggled for a few minutes, and then gave up the ghost. The bird's neck was broken and a pink liquid was oozing out of its beak. This case looked strange especially considering the fact that the Crimsonbreasted Barbet does not usually fly at such break-neck speed as the Emerald Dove obviously does. The wall mentioned here is not surrounded by much of shrubbery either. To top it all the unfortunate bird hit the wall at as low a height as six feet from the ground!

Chandramandiram,
Puthur,
Palghat, B. VIJAYARAGHAVAN
December 13, 1957.

11. *HALCYON PILEATA* INLAND

In a note by the Editors on the specimen of this species shot at Coimbatore (*JBNHS*, 53: 698) they state that it has hitherto not been recorded so far inland. As you will see in my paper on the 'Birds of Coorg', however, I came on it twice near Somwarpet at a height of 3,000 ft. on one of the small hill streams which run into the Cauvery. Though the direct distance from the sea is not as great as that of Coimbatore, the occurrence was if anything even more unexpected as the Coimbatore bird could have worked along through the Palghat gap without having to climb the hills at all while the Coorg bird was well on the eastern slope of the ghats and must have surmounted the range over very unkingfisherlike country to get where it did.

Ardura,
Craignure,
Isle of Mull, F. N. BETTS
Scotland,
October 29, 1956.

12. REDLEGGED FALCONET, *ERYTHROPUS AMURENSIS* (RADDE), NEAR BOMBAY

On 3rd December 1950, while beating for partridge in open scrub-covered country at Ambernath near Kalyan, Bombay, I shot an Eastern Redlegged Falconet (*Erythropus amurensis*) of which the distribution (*vide* F.B.I., 5: 59) is as follows:

> 'Siberia East of Lake Baikal to Manchuria, North China and casual as a breeder in the Eastern Himalayas. In winter South to South China, North-East India and South and East Africa.'

Ticehurst remarked (*JBNHS*, 34: 475) that the distribution in India was not restricted to the north-east in winter and drew attention to 'odd, mostly undated, records from Nepal, Darjeeling, Kumaon, Carnatic, Nilgiris, and Ceylon. There is a record that thousands were seen passing over Belgaum on November 24'.

The last record is obviously from a manuscript note by EHA (E. H. Aitken) in an interleaved copy of Barnes' *Handbook to the Birds of Bombay Presidency*, now in the Society's library, thus:

'Karwar, 24th November 1891. Last week, at Bolshitta, about 7 miles from here, I found large numbers of a small hawk which, if Barnes is right, must be *C. amurensis*; but there is no pale rufous, or buff, on the under parts of either female or young. I secured one mature ♂, one mature ♀, and 5 immature birds. The legs, feet, and cere of the male are red, those of the female yellow. They usually appeared at and after sunset, flying low and very swiftly over muddy fields. Examination of the stomachs of those shot proved that they were hawking large beetles, probably dung beetles, which take wing after dusk.

Majali (near Karwar) 4th November 1953. Saw one flying swiftly over wet ground after sunset. It was too dark for certain identification, but I think it must have been this bird.'

All along the coast in North Kanara Davidson (*JBNHS*, 12: 16) found this little falcon in immense scattered flocks in November-December in some years. Curiously it does not appear to have been noted anywhere in peninsular India over the last sixty years or so, though the fact that it breeds in Assam (April/May—Stuart Baker) and further eastwards, and is a regular winter visitor to East Africa (Benson, *Ibis* 1951: 467-8—arriving in December and leaving in March) would indicate that it must pass over India every year.

Benson records that they are sought after as food, being very good to eat. *Vide* also Stuart Baker, F.B.I., 5: 59.

33 PALI HILL,
BANDRA,
BOMBAY 20,
November 12, 1956.

SÁLIM ALI

13. AN INCUBATING PEACOCK (*PAVO CRISTATUS* LINN.)

As is well known, among the pheasants and particularly peafowl, the female alone incubates. When some school children reported seeing a peacock incubating eggs on an old wall on 19th September 1956, the story was not taken seriously. Next day we accidentally investigated the place and saw a peacock incubating 5 eggs. The bird was kept under observation the whole day, and it was noted that he sat patiently on the eggs for most of the time. Occasionally he left the nest and was seen feeding in the vicinity. He even danced a little once or twice. In the evening he left the nest but was back next morning.

On the 20th September 1956 six Neophrons were seen sitting on the wall and the ground around the peacock, one of them even boldly approaching and attempting to drive the peacock off the eggs. The Neophrons were driven off by a man but one egg was missing. The cock was seen incubating 2 eggs on 24th September 1956; on 25th September 1956, all the eggs were missing.

No peahen was noted at this nest, although both peahens and peacocks were constantly observed in this area.

This peacock was a fully mature bird in good plumage.

I believe a male Amherst Pheasant was noted incubating in the London Zoo. It would be interesting to know of any other records particularly in the wild state.

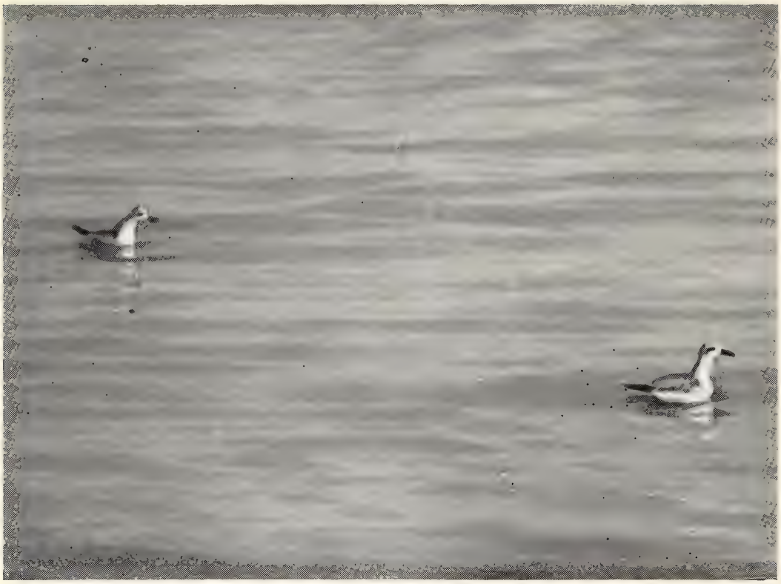
JASDAN,
November 10, 1956. Y. S. SHIVRAJKUMAR

[Although in some species of pheasants the cock assists the hen in the care of the chicks, he does not take part in nest building or incubation. The case of this peacock is certainly exceptional. We cannot trace other similar instances, whether in captivity or in the wild state.—EDS.]

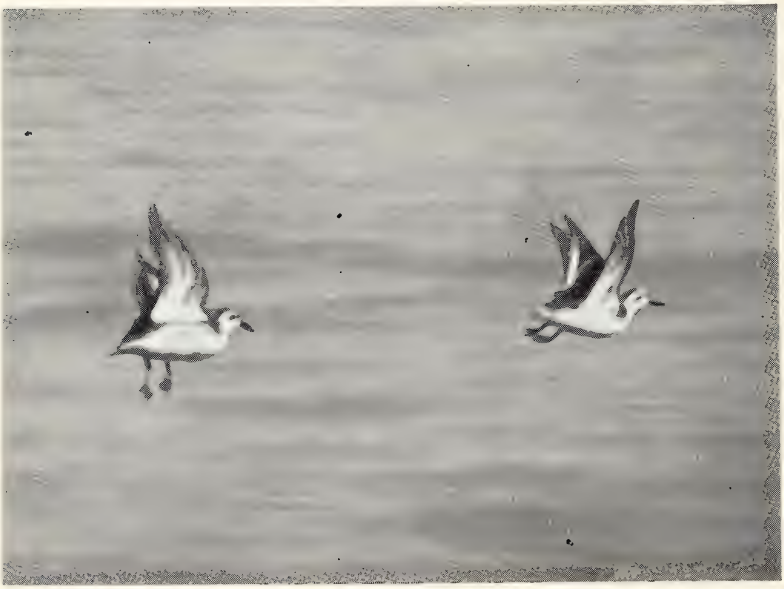
14. OCCURRENCE OF THE RUFF AND REEVE [*PHILOMACHUS PUGNAX* (LINNAEUS)] NEAR COIMBATORE

Mr. Subbiah Pillay has sent us a specimen of a Reeve shot near Coimbatore. Whistler and Kinnear in the Eastern Ghats report (*JBNHS* 39: 257) state 'only recorded in the Madras Presidency from the neighbourhood of Madras—one specimen in the British Museum and another in the Madras Museum'. It is known as a rare and irregular winter visitor to Ceylon, but for the sake of completeness it may be worth while recording its occurrence at Coimbatore. Mr. Subbiah Pillay writes that it was picked up from a bag of Spotted Sandpiper, *Tringa glareola*, and adds that though very rare in these parts, it has been shot by him on previous occasions also.

January 5, 1957. EDITORS



Rednecked Phalaropes, Bhavnagar



Rednecked Phalaropes in flight, Bhavnagar

Photos (copyright): R. S. Dharmakumarsinhji

15. REDNECKED PHALAROPE (*LOBIPES LOBATUS* LINN.) IN BHAVNAGAR, BOMBAY STATE

(*With a plate*)

We drove to the salt pans on the evening of the 28th October, 1956, to see the numerous shore birds which annually gather there. The salt pans are filled with saline water varying in depths of 1 inch to 3 feet and are about 800 yd. × 400 yd. rectangular compartments. The earthen bunds which divide the pans are about 4 to 5 feet high. The shallow basins of salt water form ideal feeding ground for all kinds of waders.

A few steps from the car and we were looking over a pan; the light was favourable, the sun at the back of us, and the first bird to attract our attention was the phalarope, it was floating in shallow water. Up went our binoculars and both of us identified it as the phalarope since it was so conspicuous and typical of the coloured pictures we had seen of this bird in winter plumage. As we drew near, the bird flew and we saw its grey and white and blackish plumage with a white wing-bar; the black nape and almost pied plumage were distinct. The phalarope flew about 40 yards and then alighted on the water like a waterfowl. This convinced us of its identity without doubt. Thereafter, we followed its movements and marked the black ear-coverts, a conspicuous feature which we had noticed at our first glance. Soon, we discovered there were two phalaropes. The salt pans were full of shore birds such as Ruff, Blackwinged Stilt, Curlew-Sandpiper, Dunlin, Little Stint, Redshank, Greenshank, Marsh Sandpiper, Lesser and Large Sand Plover, and Blacktailed Godwit.

A special characteristic of the phalarope was that, while the rest of the waders preferred to land on their feet in ooze or in very shallow water, the phalarope alighted on the surface of the water where it was deeper and began swimming in typical waterfowl manner. Within the next few days from the 28th to the 30th evening, we watched the phalaropes of which we counted five, feeding and approaching us as close as 20 yards. I took photographs while Shivrajkumar watched them. The feeding action of the phalaropes was moorhen-like, off the surface of the water. The bird had a resemblance to a Pheasant-tailed JaÇana without the long tail. We once saw a phalarope twist sharply in the air for a second while flying, only to continue its swift flight. We also saw them turn or wheel sharply while flying and they then looked very much like other small shore birds in flight.

A feature of the phalarope is the feet lobed and slightly webbed, a character which cannot be seen in the field. Phalarope means coot-footed. The slender black bill, black ear-coverts, blackish nape and hindcrown, white forehead and lower parts, ashy upper parts, coupled with the white wing-bar and snipelike design of the back, are the best pointers for identifying the bird. The above including its moorhen-like feeding behaviour and its habit of alighting on water would make it unmistakable with any shore bird of our coast. In size, it is small from 6 to 8 inches in length.

On 31st morning, we revisited the pans but owing to a strong north-easterly wind, the birds were not seen, the visibility was poor, and we thought that the birds had migrated. Other shore birds were behaving shyly and flighting frequently.

On the morning of the first of November, we were out again. This time it was a windless morning and visibility was good. A pair of Large Flamingos which we had seen earlier were there, added to this was a solitary Lesser Flamingo, Brahminy Ducks, and avocets. Masses of other shore birds had arrived. In the distance we made out 15 phalaropes swimming together, while other waders were up to their belly in water. As flighting was taking place, a small section of the phalaropes, eight of them, took wing and flew past us, their pied upper parts, reminiscent of Turnstone and almost striped like a snipe except for the white wing-bar, gave them a distinctive appearance. This was indeed a wonderful sight. The remaining seven birds were seen feeding separately and then joining up. In their behaviour we found them rather individualistic while feeding but grouping together while resting and flying. Their coloration is much like Sanderling in winter plumage and thus conspicuous, whereas in habits they differ totally.

DIL BAHAR,
BHAVNAGAR,
November 1, 1956.

SHIVRAJKUMAR OF JASDAN
R. S. DHARMAKUMARSINHJI

[With the excellent points for field identification contained in the above note it is to be hoped that more observers on our north-western seaboard will now be able to keep a proper look-out for phalaropes. It may be that they are less uncommon in winter than the lack of records suggests, and possibly are often overlooked. Ticehurst (Birds of Sind, *Ibis*, 1924: 126) found the Rednecked Phalarope a common winter visitor to the coast of Sind, swimming about and feeding actively on the calm inshore waters and lagoons as well as on small pools or shallow jheels inland. It will be recalled that only recently (Vol. 54: 190) K. S. Lavkumar and K. S. Himmatsinhji reported it from Kutch in May. The birds, presumably on northern passage, were then in the unmistakable breeding plumage, with white cheeks and chestnut-red sides of neck.—EDS.]

16. SOME RIDDLES OF GAME-BIRD MIGRATION IN KUTCH

There can be little doubt that within living observation the general pattern of the annual migration of some gamebirds into Kutch during the winter season has changed substantially, to the chagrin of sportsmen. The gamebooks of the State shoots, which have been preserved meticulously since 1901, provide a record of the more striking changes in this pattern.

Among the mysteries of the gamebird migrations must be reckoned the almost complete disappearance of the Imperial Sandgrouse (*Pterocles orientalis*) from Kutch. Although this bird was never among the more numerous visitors, it could always be relied upon to put in an appearance in numbers which ensured that it figured in shoots regularly held at any one of several particular locations and was known as far afield as Abdasa. In the first ten years of the present century, there were only three years (1903, 1904, 1906) when none was shot at these places, and these were famine years when there was little or no water to attract the birds. Between 1909 and 1921, there were ten years in which bags of between 13 and 41 were shot, with only two blank years (1910, 1911) apparently owing to water shortage; but from 1922 until 1927 there are five blank years—no Imperial Sandgrouse were seen in those localities where they had been customarily encountered. Between 1928 and 1937 there were six blank years (1929, 1931-36) but the birds, when they came, seemed to come in larger numbers. On 27th and 28th December 1930 two guns, in camp at Mokhana, accounted for 117 birds—quite a heavy bag for Imperial Sandgrouse in Kutch. 1937 was another good year, 44, 100, and 30 birds being bagged in three shoots during January and February. Since 1940, when 18 birds were shot, there has been a complete blank. No Imperial Sandgrouse have been seen or shot in their accustomed localities. Will they come back again? This blank period is by far the longest for which records are available; it includes years when there was plenty of water in Kutch. It may perhaps indicate a permanent change in the usual choice of water by the Imperial Sandgrouse.

Another mystery is the gradual change in the habits of the Spotted Sandgrouse (*Pterocles senegallus*—locally *waku*). The arrival of these birds in Kutch seems likewise influenced by the nature of the monsoon. During the first ten years of the century, there were three blank years (1903, 1904, 1906) but, when the birds came, their favourite haunt was Rudra Mata-Kunaria, near Bhuj. In 1905 one gun bagged 54 at this spot, in 1907 four guns accounted for 124, and leaving the blank years aside there were always *waku* at Rudra Mata. Between 1909 and 1919 there were two blank years (1910, 1911) when no *waku* came; but during the rest of this period the bags were steady if moderate. In 1912, 1913, 1914, and 1915, *waku* remained faithful to Rudra Mata-Kunaria; but towards the end of the period, they showed an interesting tendency to move away from this locality. From 1917 onwards, they were found again at Rudra Mata-Kunaria; in November 1919 three guns bagged 93—the best record for many years. From 1919 to 1927 there were two blank years (1920, 1921); otherwise Rudra Mata-Kunaria showed better bags than in the preceding period. For example, 1922 was a record year, 496 birds being bagged in four shoots. Throughout the period 1930-1943, *waku* continued to come to Kutch with 1931 to 1936 and 1939 as blank years when none were shot in these accustomed places; but they began now to desert Rudra Mata, and to go further away to Amrapur, Bhimasar, Lakhara-Velara, and the Banni. During this time, only a single *waku* was shot at Rudra Mata in 1937, which is a dramatic contrast with earlier bags at the same place. At the present time, *waku* are rare in Kutch, although they are still to be found in the comparatively remote area of the Banni. The reports from outlying districts, which convey news of the arrival of game birds, now scarcely mention *waku*. It would be interesting to learn whether any other area is now visited by birds which once came to Kutch.

Duck present another mystery. During the early years of the century, they always came to Kutch in fair numbers whenever the monsoon gave enough water for them. There were certain localities where a shoot could always be arranged in the assurance that good sport would be forthcoming. As an example, the shoots at Ningal and Ratnal may be given for the year 1922. In January of that year eight guns bagged 116 birds, in February six guns got 98 birds, in the following December eight guns bagged 213 birds. Devisar and Dhonsa too would usually provide their quota. Owing to the frequent monsoon failures with which Kutch is afflicted, there are always a number of blank years when no duck can be expected—for example 1923, 1926, and most of the years in the middle thirties. But when conditions were favourable, the ducks always came, whether in greater or lesser numbers. Of late years, when the assembly of experienced guns was more difficult, bags were naturally smaller; but when the water was there, the ducks were found in their accustomed spots. It has been noticed, however, during the last few years, that they have been coming in smaller numbers; and that even when the rains have been good, there have not been as many as used to be. The spots which were once favourites of theirs are now deserted by them; and this year, extraordinary to say, when Kutch is green, when the tanks and lakes are fuller than has been the case for many years, there are practically no duck at all. If the last monsoon had been a bad one, the absence of the duck would not be surprising; but the fact that none have come, even when conditions are favourable, taken along with the fact of the steady fall off in previous years, suggests that some definite change is taking place in the migration-pattern, which has influenced their arrival in Kutch for the last half century. In this connection the article *Ducks Unlimited* in the December 1956 number of the *Journal* is very suggestive. The trouble in Kutch is certainly not over-shooting; it must also, as in North America, lie with breeding grounds. Can it be that large scale developments in U.S.S.R. connected with land reclamation, or even with atomic weapons, have caused the shortage which we have noticed? Comparison with observations along similar lines to the above, gathered in other parts of India, might be interesting.

RANJIT VILLA,
BHUJ, KUTCH, H. H. MADANSINHJI OF KUTCH
January 30, 1957.

17. THE LIVER FLUKE OF THE FROG, *RANA TIGRINA*—A NEW RECORD OF *MEHRAORCHIS RANARUM* SRIVASTAVA, 1934 (PLEUROGENITINAE)

Srivastava (1934) reported a new trematode *Mehraorchis ranarum* encysted in the body cavity, specially in the pancreatic region of *Rana cyanophlyctis*. My colleague Dr. R. Rakshpal, to whom my thanks are due, pointed out a dissected *Rana tigrina* in the B.Sc. class, which showed a large number of very small cysts attached to lungs, intestines, kidneys, etc. The cysts were examined and found to be only bacterial. The general examination of the various organs revealed infection of liver and gall bladder only. The liver showed white spots on its lobes, which gave these a pathogenic appearance. The liver had 16 liver flukes in its bile ducts. All the flukes were fully gravid. The gall bladder which was very much inflated was full of trematode eggs, which were later found to be of the flukes recovered from the liver. The flukes resembled *Mehraorchis ranarum* Srivastava, 1934. The general shape of the body and the topography of the various organs were as described by Srivastava (1934). The spines on the body were quite sharply distinguished and were projecting out of the surface very conspicuously, at least along the anterior end and the margins of the body. These were densely crowded at the genital opening. The uterine coils extended, in the majority of the specimens, beyond the intestinal caeca posteriorly and the caeca were more or less hidden under the coils all along their length. The vitellaria extended up to the levels of the anterior end of the pharynx and the posterior end of the ventral sucker. At least in their anterior region the vitellaria of the two sides continued in the middle of the body, even overlapping the oesophagus. The measurements of the various organs though different from those given by Srivastava (1934) were not taken into consideration as the flukes were found to be of the same type.

As no flukes have so far been recorded from the liver of frogs in India, I have called it the liver fluke of frog.

DEPARTMENT OF ZOOLOGY,
LUCKNOW UNIVERSITY. R. S. TANDON
December 29, 1956.

REFERENCES

Srivastava, H. D. (1934): *Bull. Acad. Sc.*, U.P. 1934.

18. TICKS FROM BALUCHISTAN, WEST PAKISTAN

During the Peabody Museum-Harvard Expedition to West Pakistan, 1955, some *Ixodoidea* were collected.

1. **Hyalomma excavatum.** A specimen was obtained by the writer at Little Kapoto, 10 miles south of Kalat.

2. **Hyalomma marginatum.** One specimen collected at Koh-e-Murid, 2 miles south of Turbat in Mekran, by Naem Beg Chugtai, University of Karachi Zoologist, from the bark of an acacia tree (*B. kahur*). This large tree is held sacred by the Zikris, a religious sect in Mekran.

The determinations were made by Dr. Harry Hoogstraal, U. S. Naval Medical Research Unit No. 3, in Cairo.

3551 MAIN HIGHWAY,
COCONUT GROVE, HENRY FIELD
FLORIDA, U.S.A.,
November 14, 1956.

19. BIONOMICS OF THE PUMPKIN CATERPILLAR, *MARGARONIA INDICA* SAUND

There are two points I would like to mention in connection with Messrs. Patel and Kulkarny's paper under the above title (1956, *Journ. BNHS.*, 54: 118-27).

Firstly I consider that the figure of the pupa is somewhat misleading as it shows the wing-markings of the pharate imago, which would not be visible until shortly before emergence.

Secondly it may be of interest to record that I have collected many hundreds of examples of this moth at both ordinary and mercury vapour light during the last thirty years or so in both India and East Africa and I have never seen a female. In all the other *Margaronia* species that I have known attracted to light, females are as common as males and very often more so.

Mombasa, D. G. SEVASTOPULO,
January 25, 1957. F.R.E.S.

20. A NEW PEST OF SCREWPINE IN KERALA, *AGONIA FUSCIPES* BALY (HISPINAE, CHRYSOMELIDAE)

(*With four figures*)

Screwpines (*Pandanus* spp.) are of considerable economic importance in Kerala. Leaves of these plants are used in making mats, baskets, and fancy articles, a premier cottage industry of the State. The important pests so far recorded on screwpines are the cetonid *Agestrata orichalcea* L., the pyralid *Acara morosella* Wlk., and the tettigonid *Sexava nubila* Stall. in Dutch East Indies (Leefmans, 1927 *a*, *b*), the tineid *Aeolarchis sphenotoma* Meyr. and the curculionid *Diathetes pandanae* Zimm. in Fiji (Lever, 1938, Zimmerman, 1939). The only insect recorded on screwpines in India is *Leptocorisa varicornis*, but its relationship with the host plant is not known (Pillai, 1923). *Agonia fuscipes* Baly (Hispinae, Chrysomelidae) has been recorded for the first time as a pest of screwpines.

At Vellayani, Kerala, *A. fuscipes* has been observed attacking different varieties of screwpines all the year round. This appears to be the first time *A. fuscipes* is recorded in India and is of economic importance. The present contribution embodies observations made on the insect.

Life-History and Morphology

Egg (Fig. 1, *A*, *B*). The eggs are laid singly, on the undersides of leaves. Unlike those of many other hispids the eggs of *A. fuscipes* are not sunk into the leaf tissues but are wholly on the leaf surface. The egg is normally situated nearer the base than the tip of the leaf; it lies with its long axis parallel to the midrib. Adhesion of the egg to the leaf surface is strong and lasting; the empty shell remains on the leaf long after the contained egg has hatched. Soon after the egg is laid, the female beetle covers it up with a convex broadly oval mass of excrementitious matter consisting mostly of partly digested fragments of screwpine leaf tissue, irregularly arranged and stuck together. If the beetle is disturbed while constructing this covering, it moves away never returning to complete the work.

Egg with its covering measures 4 × 3 mm. The outer covering is easily removed with a needle exposing the egg. Egg proper is oval, flat ventrally being in contact with leaf surface and convex dorsally. Chorion is smooth and light yellowish brown; it flattens out to form a thin flange all round the egg. The flange and ventral surface of egg adhere firmly to leaf, together forming a plane surface. Egg with flange is 3.5 × 2.5 mm. and egg proper 2 × 1 mm.

Egg hatches out in 14-16 days in December to January.

Larva (Fig. 1, *C*). The grub effects its exit from the egg through a slit made in the chorion ventrally and directly cuts its way into the leaf and starts mining. Direction of the mine depends on the orientation of the egg. Initially the mine is about 4 mm. broad, gradually it broadens out to 10-15 mm. as the grub grows. Mine constructed by one grub is confined to one side of the midrib. The grub feeds on the

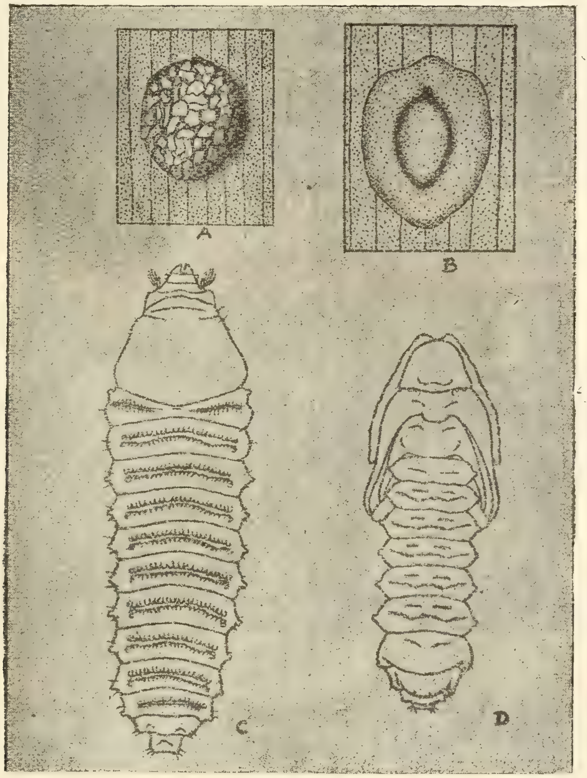


Fig. 1

(A) Egg with excrementitious covering, (B) Egg with covering removed, (C) Fullgrown grub, (D) Pupa, dorsal view) green tissue within the leaf. Inside the mine it is capable of energetic and rapid movements backward and forward. When removed from the mine, the grub is incapable of re-entering a leaf. There are three larval instars. Larval period is 71 days during February to May.

External morphology of the grub is more or less the same in all the instars. Fullgrown grub, 16 × 4 mm., is elongate, considerably flattened with characteristic form of leaf-miners. It is broadest across the 2nd thoracic segment, narrows slightly and regularly towards the posterior end and steeply towards the anterior end. Flattening is more pronounced at anterior and posterior ends than in the middle. Mouthparts, head between antennae, anterior border of dorsal and ventral prothoracic plates are dark brown in colour; rest of head, antennae, prothoracic plates, light brown and body yellowish. Head, deeply sunk inside prothorax; only mouthparts and antennae protrude; strongly flattened, cranial structure being almost lost. Epicranial halves elongated into lobes imbedded in prothorax. Labrum, maxillae, and labium considerably reduced in structure. Mandibles strong, well-developed, form a cone along epicranial margin. Each mandible with two sharp chitinous blades along inner side enclosing a cavity. Antennae short, three segmented, 2nd segment largest, 3rd smallest; 2nd segment surmounted by one sensory peg and three sense hairs; 3rd segment surmounted by three sense hairs. Body, strongly segmented, with three thoracic and ten abdominal segments. Prothoracic segment largest, roughly triangular; with two similar strongly chitinised, hard but pliable plates, one dorsal and one ventral. Mesothoracic segment, the broadest, constricted in the middle and rounded laterally. Metathorax and first eight abdominal segments similar in form, being broader than long and approximately rounded laterally. 9th segment narrower than 8th and truncated laterally. 10th segment considerably narrower than the 9th, subcylindrical; bears anus ventrally. A chitinised, short, cylindrical, peg-like structure borne on each side of mesothoracic and first eight abdominal segments, it projects sideways and bears the spiracle laterally. This structure and disposition of the spiracles are unique among hispid grubs. A transverse furrow present across first seven abdominal segments, both dorsally and ventrally; each furrow bordered by slight segmented ridges. Only ends of furrow present dorsally and ventrally on mesothorax, present in whole dorsally and only ends ventrally on metathorax and present in whole dorsally and absent ventrally on 8th abdominal segment. These furrows and ridges appear to be useful to the legless grub in movements inside the mine. Skin of grub very minutely wrinkled; all body segments with a few minute hairs laterally.

Pupa (Fig. 1, *D*). Pupation takes place inside the larval mine. The pupa measures 12 × 4.5 mm. It is golden-brown in colour; mouthparts antennae and eyes turn dark brown with development. Head, mouthparts, and prothorax resemble those in adult. Among thoracic segments prothorax is largest and mesothorax smallest. Sheaths of antennae, legs, and wings closely apposed to body. Abdomen is strongly segmented with ten segments. First seven segments more or less of similar form and size; each segment is broader than long and rounded laterally. 8th segment smaller than

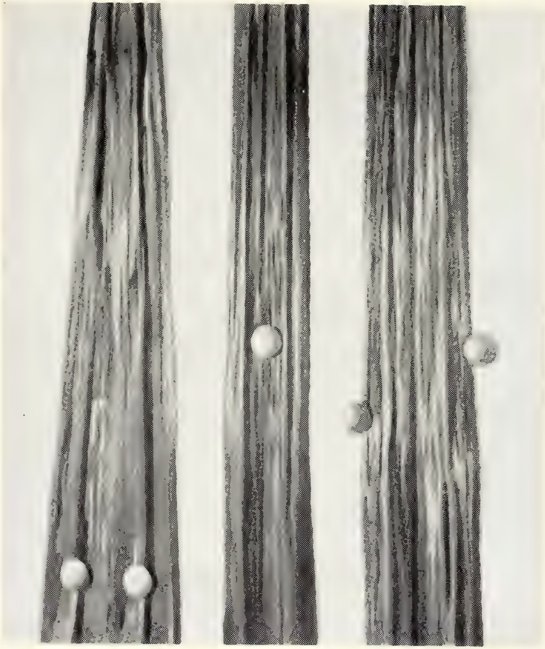


Fig. 2. Screwpine leaves showing feeding-scars made by adult beetles.

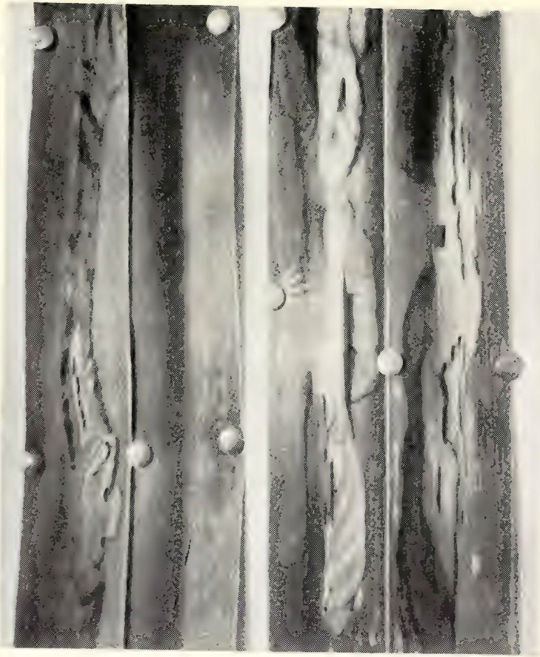


Fig. 3. Screwpine leaf showing larval mines.

(Rounded objects seen in the figures are pins fixing the leaves)

Photos : G. K. Nair

7th and slightly flattened laterally. 9th segment very narrow, reduced in size; possesses a notch on posterior edge of sternum into which fits the small hexagonal 10th segment. Spiracular pegs of the type found in grubs are borne laterally on first six abdominal segments. A transverse ridge surmounted by a row of minute, black spines is present dorsally near the posterior margin of each of segments 2 to 6; each ridge is curved anteriorwards middorsally. Smaller ridges with spines are present one on either side of middorsal line in front of the posterior ridges; the smaller ridges alone being present on 7th segment. Body surface with very minute wrinkles; few small hairs present on the segments laterally. Pupa is capable of only slight movements. Pupal period is 14 days in August.

Adult (Fig. 4). The adult beetle effects its exit from the larval mine through a slit it makes on the thin wall of the mine. Sexual dimorphism is not marked in the beetles, but the sexes can nevertheless be distinguished by the smaller size of males. Average measurements of female and male are 12 × 4 mm. and 10 × 3.5 mm. respectively. Further, in males the elytra are almost parallel-sided, in females they are slightly wider posteriorly.

The beetles are capable of crawling and flying, but they very seldom fly. During daytime they usually lurk in the axils of leaves. When disturbed they either drop to ground or crawl back into the deep recesses of the leaf axils. Feeding takes place on both sides of the leaves and the beetle consumes the epidermis of the side on which it feeds and the mesophyll; epidermis of the opposite side is left intact. The feeding-scars are short, narrow, straight lines, parallel to the midrib. Distal half of the leaf is preferred by the beetle for feeding.

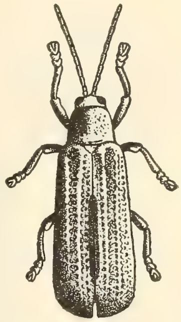


FIG. 4.—The adult beetle, *Agonia fuscipes* × $2\frac{1}{2}$.

DAMAGE CAUSED: ECONOMIC STATUS

The nature of damage caused by the adult beetles and the larvae to screwpin leaves are shown in Figures 2 and 3 (Plate) respectively. The grubs mine the leaves and the adults make feeding-scars on them. The thin epidermal walls of the larval mines get dried up and eventually tear and break away, rendering the leaves unfit for use. Leaves with feeding-scars break along these scars in the wind and present a ragged appearance. Such leaves also are unsuitable for making mats and other articles. In cases of severe attack most of the leaves show either one or the other, or both the types of damages. *A. fuscipes* can thus be ranked as a major pest of screwpine.

ACKNOWLEDGEMENTS

The beetle was identified at the Commonwealth Institute of Entomology. Thanks are due to the Director, Zoological Survey of India, Calcutta, who arranged for the identification. Thanks are also due to Mr. M. C. Cherian, Principal, and Mr. K. V. Joseph,

Entomologist, Agricultural College, Vellayani, for their helpful suggestions and facilities provided.

Asst. Entomologist,
Agricultural College,
Vellayani,
Kerala.
December 8, 1956.

M. R. G. K. NAIR

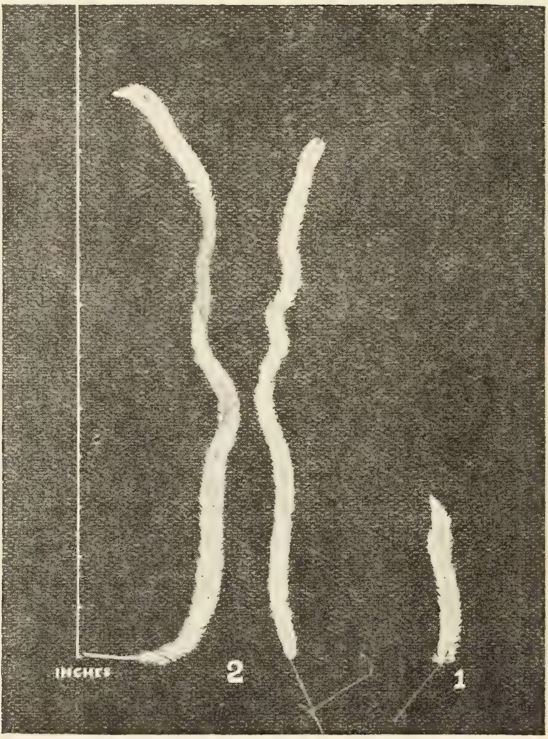
References

Leefmans, S. (1927 *a*): *Korte Meded. Inst. Plantenziekten*, No. 4.
— — — (1927 *b*): Ibid, No.2.
Lever, R. J. A. W. (1938): *Agric. J. Fiji.* **9** (3).
Pillai, N. K. (1923): *Rept. Dept. Agric. & Fisheries, Travancore,* 1921-22.
Zimmerman, E. C. (1939): *Proc. Havaii Ent. Soc.*, **10** (2).

21. A GIANT FORM OF *CELOSIA ARGENTEA* L.

(*With a photo*)

Celosia argentea L. (*Amarantaceae*) is a tropical weed spread all over India, sometimes ascending the hills up to 5,000 ft. The species is an annual ranging from three to four feet in height, carrying white spikes which attain a length of four inches (photo, fig. 1) with a pinkish tinge towards the apex of the inflorescence. Hooker recorded a length of eight inches in the inflorescence. The leaves exhibit great variation with regard to size and shape.



During a recent visit to Rajapalayam (Ramanathapuram District, South India) a giant form of the above species was found occupying extensive areas of cultivated fields, of mostly black soils. The species makes its appearance after the harvest of Sorghum (*Jowar*). The plants were comparatively larger, reaching a height of six feet, bearing very narrow and ash-coloured leaves. The inflorescence which was eight to thirteen inches in length attracted attention and plants presented a white appearance, being populated with over a hundred spikes each. The variation was interesting in as much as all the plants in the locality were of this form. The floral characters however agreed with the normal species. Cytological studies are being pursued which may throw further light on this giant form.

AGRICULTURE RESEARCH INSTITUTE,
COIMBATORE, J. SAKHARAM RAO
October 22, 1956.

[This species is a very variable one; at the end of October it can be seen in many parts of Bombay State, going up to 6-7 ft. tall, with rather large inflorescence spikes; but the length of the spikes mentioned in the note is out of the ordinary.—EDS.]

22. *ECLIPTA PROSTRATA, E. ERECTA*, OR *E. ALBA*: WHICH IS THE CORRECT NAME?

The nomenclature of this plant has often given me much trouble in the past; in our floras the plant is known under the name of *Eclipta alba* or *E. erecta*; foreign authors favour *E. prostrata* Linn. The present note is written to clarify the position.

Linne in *Species Plantarum*, 1753, listed three specific names for what he took to be three different plants, but which have been proved to be identical: *Verbesina prostrata* Linn. (page 902), *Verbesina alba* Linn. (page 902), and *Verbesina pseudo-acmella* Linn. (page 901). The three names, *prostrata*, *alba*, and *pseudo-acmella*, are generally accepted as belonging to the same plant, of which there are a number of different forms; these forms do not amount to varieties. In face of the Rule of Priority these three names stand equal, since they were all published in 1753; the International Code does not accept page priority, though some authors, particularly American ones, do accept it.

The general custom, which is not regulated by any rules of the International Code, is to adopt the name that was selected by the author who treated of these plants in a subsequent taxonomic book or paper under the name of *Eclipta*. Linne himself in 1771 gave the following two plants: *Eclipta prostrata* Linn. Mant. 2: 286, and *Eclipta erecta* Linn. ibid. It is clear that from among the 1753 names Linne selected *prostrata* for this plant; the name *erecta* is a new one dating only from 1771, and therefore according to the Rule of Priority must give way to *prostrata*.

The nomenclature and synonymy of this plant is, therefore, the following:

Eclipta prostrata (Linn.) Linn. Mant. 2: 286, 1771; Roxb. Fl. Ind. 3: 438, 1832.
  Verbesina prostrata Linn. Sp. Pl. 902, 1753.
  V. alba Linn. Sp. Pl. 902, 1753.
  V. pseudo-acmella Linn. Sp. Pl. 901, 1753.
  Cotula alba Linn. Syst. 2: 564, 1767.
  Eclipta erecta Linn. Mant. 2: 286, 1771; Lamk. Illustr. t. 687, 1796-1797; Dalz. & Gibs. Bombay Fl. 117, 1861; Cooke, Fl. Bombay Pres. 2: 38, 1904.
  Eclipta alba (Linn.) Hassk. Pl. Jav. Rar. 528, 1848; Dalz. & Gibs. Bombay Fl. 117, 1861; Clarke, Comp. Ind. 134, 1876; Hook. f. in Fl. Brit. Ind. 3: 304, 1881; Gamble, Fl. Madras 705, 1921; Santapau in Rec. Bot. Surv. India 150, 1953.

It is clear, therefore, that the only correct name of this plant is *Eclipta prostrata* Linn., all the other names going into the synonymy.

ST. XAVIER'S COLLEGE,
BOMBAY 1, H. SANTAPAU,
January 30, 1957. S.J., F.N.I.

[Article 57 of the International Code of Botanical Nomenclature, 1956 edition, regulates such cases as the present one very clearly; Art. 57 states: 'When two or more taxa of the same rank are united, the oldest legitimate name or (for taxa below the rank of genus) the oldest legitimate epithet is retained, unless a later name or epithet must be accepted under the provisions of Art. 58. The author who first unites taxa bearing names or epithets of the same date has the right to choose one of them, and his choice must be followed.' The 1956 edition of the Code was not at hand when the above note was written.—EDS.]

23. *ALTERNANTHERA PARONYCHIOIDES* ST. HIL.—A CORRECTION

In a previous number of this journal (53: 525, August 1956) Mr. D. D. Sundararaj mentioned under No. 5 the following:

'*Alternanthera paronychioides* St. Hil. Voy. Brés. II, 2: 439, 1833.
  Syn. *Achyranthes polygonoides* (Linn.) Lam. Encl. 1: 547, 1785.
    Alternanthera polygonoides R. Br. Prodr. 417, 1810

A native of tropical America. Reported first in India by Raizada as occurring on the banks of the Ganges in Cawnpore and Benares. (*J. Ind. Bot. Soc.*, 15: 149-167).'

This citation calls for comment on several counts. The first is that the *J. Ind. Bot. Soc.* referred to does not mention this plant at all; there are two papers only by Raizada in the same volume, none of which mentions the plant.

The second and more important comment concerns the nomenclature of the plant in question. The names were published at the following dates. *Alt. paronychioides* St. Hil. 1833; *Achyr. polygonoides* Lam. 1785; *Alt. polygonoides* R. Br. 1810; the reference to Linne in '*Achyranthes polygonoides* (Linn.) Lam.' probably refers to *Gomphrena polygonoides* Linn. 1753, though Lamarck, loc. cit., does not give such a reference to Linne. It is clear that in accordance with the principle of *Priority*, the oldest name is the valid one, otherwise the reasons for the refusal of the oldest name, *polygonoides*, should be indicated. As Mr. Sundararaj has put it, the nomenclature is decidedly against the principle of *Priority*.

There seem to be two plants, which though different in themselves, have become rather mixed up in the literature; their nomenclature is the following:

1. **Alternanthera paronychioides** St. Hil. Voy. Brés. II, 2: 439, 1833; Schinz in Engler & Prantl, Die Natürlichen Pflanzenfamilien, ed. 1, III, 1 *a*: 115. (Omit the synonymy as given in *Journ. Bombay Nat. Hist. Soc.* 53: 525.)

2. **Alternanthera ficoidea** (Linn.) R. Br. ex R. & S. Syst. 5: 555, 1819; Merrill, Enum. Phil. Fl. Pl. 2: 131, 1923; Backer in Fl. Males. I, 4 (2): 93, 1949.
   Gomphrena ficoidea Linn. Sp. Pl. 235, 1753.
   G. polygonoides Linn. Sp. Pl. 225, 1753, pro parte.
   Alternanthera polygonoides R. Br. Prodr. 416, 1810.
   Telanthera polygonoides Moq. in DC. Prodr. 13 (2): 363, 1849.

Moquin in DC. Prodr. 13 (2): 358 lays much stress on the structure of the staminodes for the identification of some of the species of *Alternanthera*. According to him, the staminodes of *Alt. paronychioides* are 'much shorter than the filaments (of the stamens), dilated, subirregular, irregularly 2-4 toothed at the apex, margins entire', whilst the staminodes of *Alt. ficoidea* (=*Telanthera ficoidea* Moq.) are 'longer than the filaments, elongated, ligulate, multifid at the apex, margins entire'.

There seems, then, to be no doubt that the two plants are different from each other, but to judge from the confusion in the literature the identification of the plants is a matter of some difficulty.

ST. XAVIER'S COLLEGE,
BOMBAY,
December 13, 1956.

H. SANTAPAU, S.J.

24. *HABENARIA PANCHGANIENSIS*—NEW NAME FOR A BOMBAY ORCHID

Blatter and McCann, in this journal (35: 19-20, tt. 4-5, 1932) described a new species, *Habenaria variabilis*, from Panchgani on the Western Ghats. The plant seems to be endemic in Panchgani and its neighbourhood, as it has not been reported from any spot other than Panchgani and Mahableshwar; in the latter place it is abundant and common on rocky ground in the middle of August.

The Panchgani plant is quite distinct in many of its characters and well deserves specific rank; the name, however, needs modification, as it is a *later homonym* in the sense of the current edition of the *International Code of Botanical Nomenclature.*

Ridley, in *Journ. Bot.* (*Lond.*) 24: 294, 1886, described another *Habenaria variabilis* from Abyssinia; the species is accepted as valid by Kranzlin in *Bot. Jahrb.* 16: 144-45, 1892. We have not seen the type of Ridley's plant, but comparison of the descriptions of these two orchids shows that the two plants are quite different, and therefore cannot go under the same name. In these circumstances, the older plant retains its name; the Panchgani plant must have a new name in accordance with the Rules. For our Indian plant we propose the name *Habenaria panchganiensis*, to commemorate the place where the plant was first collected and where it seems to be more or less endemic.

The one point in which both plants agree is the great variability in their floral structures, which can be judged from Ridley's description and from McCann's plates in the *Journal*, loc. cit. The nomenclature of our Indian plant is the following:

Habenaria panchganiensis Sant. & Kapadia, nom. nov.
Syn.: *H. variabilis* Blatt. & McCann in *Journ. Bombay Nat. Hist. Soc.* 35: 19-20, tt. 4-5, 1932 (non Ridley, 1886).

St. Xavier's College,
Fort, Bombay,
January 2, 1957.

H. SANTAPAU, S.J., F.N.I.
Z. KAPADIA, B.SC. (Hons.)

25. WILD LIFE PRESERVATION IN INDIA

Predator Control and the Introduction of Exotic Species

I must confess to being shocked by parts of Colonel Guman Singh's article on 'Game Preservation in Jammu and Kashmir State' in your August number, and do wonder whether the views expressed on predator control and the introduction of exotic species have the support of your Society. The editorial disavowal at the foot of page 649 seems very mild. I hope you will not mind my giving my personal views, for what they are worth; I am not writing as Secretary of the Fauna Preservation Society, for I have not discussed the matter with the Council.

Predator Control. This is certainly a controversial subject, but the following principles do seem generally applicable. There may of course be exceptions—indeed the black bear may well be a special case in Kashmir. (Is not 'vermin' an out of date conception, implying as it does the existence of good and bad animals?):

(1) If the object is to keep the population of any animal at a balanced level, wild deer for instance, predator control is dangerous and may quickly lead, through over-population of the herbivorous animals, to destruction of the plant cover, and finally to desert conditions with the collapse of the herbivorous population. The classic example is, of course, the Kaibab in U.S.A.

(2) If the object is to produce an artificially high animal population, so that man, instead of another animal, may kill the surplus, the effectiveness of predator control is arguable. Pheasant breeding in England is an example—stoats, weasels, and hedgehogs are still killed by gamekeepers and it is generally believed that a higher population of pheasants results. But if this is applied to large animals, it must be remembered that the sportsman is highly selective in his killing. He has no use for under-sized or half-starved beasts. So if the vegetation is being destroyed by overgrazing, he will not take the place of the removed predator, and still further land deterioration will result.

(3) When a predator is doing damage, it is that individual animal which should be destroyed. War should not be waged indiscriminately against his whole species; they may well be working for mankind in other ways, for example in controlling the numbers of rodents.

(4) Bounties as a means of predator control lead to many abuses and are seldom effective.

(5) A very much debated case, which is still under experiment, is that of wolf control in Canada. Does killing the wolves really benefit the caribou herds on which they prey?

Introduction of Exotic Species. I should have thought that the introduction of exotic species had got beyond the state of being highly controversial, at any rate from a scientific point of view. There can seldom be room ecologically for a new animal species without ousting an indigenous one or doing harm to the indigenous flora. Colonel Guman Singh is peculiarly unfortunate in his statement that deer in New Zealand have thriven well. I need hardly tell the Bombay Natural History Society that deer in New Zealand have so devastated the vegetation that they are that country's greatest menace. The New Zealand Government's official object is to destroy every single deer—a particularly wretched result of introducing animals for sport.

Another example of introduction without sufficient forethought was the 1,200 reindeer introduced into Alaska at the end of the last century. They had become 250,000 by 1940. Then overgrazing (in this case of winter food, lichens) caused starvation and a reduction of the population to 25,000 in 1950, a drop of 90%. F. F. Darling says (*Oryx* II No. 5, p. 283) that at the peak period 1934 there were estimated to be 650,000 reindeer in Alaska.

Should not each country strive to conserve its own typical flora and fauna and hesitate long before introducing exotic species, the final effect of which is usually impossible to foresee?

c/o THE FAUNA PRESERVATION SOCIETY,
c/o ZOOLOGICAL SOCIETY OF LONDON, C. L. BOYLE
REGENT'S PARK, N.W. 1,
November 22, 1956.

[Dr. Ira N. Gabrielson, President, Wildlife Management Institute, Washington, D.C., who is an international authority on wildlife problems, comments on the above as follows:

'I certainly agree with the views expressed in C. L. Boyle's letter on predator control; most biologists who have had experience with the introduction of exotic species expect bad rather than good results. Fortunately, most such introductions fail, and so produce no bad results other than wasting the money spent on them.

'There are a number of cases of introduced species that have become first-class pests; for example, the European house sparrow and the starling in the United States, the American muskrat in parts of Europe, the mongoose in many of the West Indian and other islands, the rabbits in Australia, and a great number of introduced species in New Zealand, the most destructive of which seems to be the red deer. I recently read a report that single hunters employed by the government to reduce the numbers of these animals were reported to have killed as many as 2,000 deer each in a single season. The carcasses were left on the ground. This is certainly a wasteful way to use natural vegetation and a wasteful way to use an animal that has good food value.

'In the United States, the introduction of exotic species is now carefully controlled in many States, and there are Federal laws prohibiting the admission of many of the animals that have caused trouble either in parts of North America or other parts of the world. Such introductions as are sanctioned are taking place under very carefully controlled conditions, and are preceded by studies of the territory in which it is proposed to introduce a species and a study of that species in its natural range with ecological conditions.

'Up to the present, there has been little success with most exotics. While many hundreds of thousands of dollars have been spent in this country in the past fifty years in introducing exotic game birds, only the ring-necked pheasant has established itself over a wide area. Hungarian partridges have established themselves and did well for a while, and then have gone down drastically in most of the range they had occupied. The chukor partridge has done well in some of the arid western States, but failed in others that seemed to be identical. There is a lot to be learned about the reasons for the success and failure of this bird before it can become very widespread in the United States, although some progress is being made.

'In each case these birds have succeeded in habitat where there are no gallinaceous birds to compete with them. Where there is competition from similar birds, none of the introductions have been successful.

'From the background and experience we have had in this country, we certainly would advise anyone to go slow in introducing exotic species and to be very sure that the animal, if it is successful in establishing itself, is not going to become a nuisance, or worse.'

We trust that, in our efforts to boost our stocks of game animals by the introduction of exotic species for the benefit of sportsmen and for the revenue expected to be derived therefrom, an understanding appraisal will first be made of the sorry and costly experiences of other countries.—EDS.]

GLEANINGS

Extracts from 'The New Conquest of Central Asia' (Natural History of Central Asia, Volume 1) by Roy Chapman Andrews. Published by the American Museum of Natural History, New York 1932.

Voles

Near Tsetenwang 'on the flat ground at the entrance to the canyon there was a vast colony of meadow voles, *Microtus brandti*. I have never seen so many individuals of a single species of any mammal. To say hundreds of thousands is not over-stating their number. The plain was literally alive with them and one could not step without treading on their burrows, which were connected by tiny paths. A continual high-pitched chirping sounded like thousands of crickets underground. They appeared to be almost entirely diurnal, for our traps caught many more during the day than at night and we saw them at all hours.' (p. 75)

Speed and other notes on the Wild Ass

'The highest speed that it could reach was forty miles an hour; however, this could be maintained for only a short dash, perhaps two furlongs. Subsequently we found that only a few of the fleetest individuals could reach that speed but that all could do thirty-six miles an hour when galloping full out. Thus there was a difference of four miles an hour between the speed of the slowest and the fastest animals.[1]

'To me the most amazing exhibit was the endurance of the wild ass. The stallion which we followed travelled twenty-nine miles before it gave up and lay down. The first sixteen miles were covered at an average speed of thirty miles an hour, as well as could be estimated. During that time there never was a breathing space; it would sometimes slow up to twenty-five miles an hour, when it had evaded us by a sharp turn, but a few moments later would speed up to a rate of forty miles as it tried to cross in front of the car. Once we pounded along fifty feet apart for a considerable distance at thirty-six miles an hour.

'After sixteen miles the ass began to slow up perceptibly but kept doggedly at it, averaging almost twenty miles an hour for four miles more. Then he reduced his speed to a slow canter and resorted to more frequent twisting and turning to throw us off his track. Finally the animal stood quietly and Shackelford decided to lasso him. Fortunately, I did not fasten the end of the lariat to the car as Shackelford had suggested, for the instant the rope settled over the animal's neck it lashed out with both hindfeet, badly damaging the radiator, and then started off on a sharp angle at twenty-five mile an hour sprint.

---

[1] Compare this with estimates given for the Kutch Wild Ass: 26 m.p.h. (Mosse, *JBNHS*, 29: 275) and 30-32 m.p.h. (Sálim Ali, ibid, 46: 476).—Eds.

'We had other opportunities later to check our observations as to speed and feel sure that we are correct in saying that forty miles an hour for a short dash is the greatest speed any of the Mongolian wild asses can reach. However, this is considerably better than a wolf can do, for after several runs we were convinced that thirty-six miles an hour is the Mongolian wolf's fastest pace. The wolf is the only natural enemy of the wild ass.' (pp.111-112)

'Like the desert gazelles, the "kulon" seeks a flat plain upon which to drop its young. They are particularly careful to avoid a region of ravines or gullies which might give cover to wolves. Also like the gazelles, they gather into herds, largely composed of mares, just before the young are born. The stallions do not entirely leave them but remain somewhat separated. Later in the summer many of the males range by themselves. The solitary individuals which we saw were invariably stallions.' (p. 115.)

'. . . On the great plain north of Tsagan Nor, however, where two or three thousand wild asses had gathered to foal, I did not see a single wolf, and carcasses were left untouched except by birds.' (p. 115)

'The "kulon" (Wild Ass) seemed to prefer the hard gravel plains and would run into the sandy country only when we approached in the car. They appeared to know instinctively that we could not follow them there and would always make a direct line for soft ground, or into the lava flows which cap part of the region about Loh.

'The car had an irresistible attraction for them, as it did for the gazelles, ponies, camels and all other animals on the plains. When we were running an ass, it would make a supreme effort to cut across in front of us, sometimes missing the car by only a few feet. If there were several hundred asses upon the plain, we needed only to drive up the center to have the animals come in diagonally from both sides, as though drawn by a magnet; after a few miles the whole mass would be thundering along in front of us. Usually such a spectacle was too much for gazelles in the vicinity and they, too, would join the procession.' (pp. 115-116)

Fauna at Tsagan Nor

'In the marsh-grass and rank vegetation beside the lake, a green insect, like a large mosquito, swarmed in countless thousands. Just at dark these began to rise with a hum like distant motors. The noise was quite appalling and we thought that we should be forced to leave; but fortunately the insect is exclusively a vegetable feeder and did not annoy us in the slightest. They formed a stratum three feet thick and seemed to be following the lake shore from west to east. The flight line lay four feet above the ground, and below that level there was hardly an insect. Not many came into the tents when the candles were lighted, and there were no mosquitoes or sand flies; in fact, it was an ideal summer resort.' (pp. 120-121)

Hedgehog

A tame hedgehog placed together with an eighteen-inch alligator, killed it by almost entirely devouring the right hind leg and eating a large hole into its abdominal cavity. (p. 122)

Abundance of antelopes near Gurbun Saikhan Mountains

'Well over toward the mountains we had an amazing spectacle of wild life—the largest herd of antelopes I had ever seen. The entire horizon appeared to be a moving line of yellow bodies and curving necks. As we ran toward them in the car, the great herd divided into groups of bucks, does and young. Thousands passed in front of us, sometimes stopping to gaze curiously at the car, or running just fast enough to keep at what they thought was a safe distance.

'Nowhere else, except in Africa, would it be possible to see such a herd of wild animals. We estimated that at least six thousand were immediately in front of us, but there may have been twice that number, for the yellow groups stretched far beyond our sight. They were feeding upon rich grass along the lower slopes of the Gurbun Saikhan, where the mountains insured a greater rainfall. They belonged to the short-tailed species, *Procapra gutturosa,* which lives only on the grasslands. (p. 219.)

'. . . There was not a sign of human life, but a dry lake-bed ran the entire length of the valley, which swarmed with antelope and wild asses. They were feeding on alfalfa, and we found this plant growing wild at half a dozen spots in other parts of the Gobi. I never have seen such a concentration of game in a small area. Antelopes were running beside the car and crossing our course every moment; tiny fawns hardly larger than rabbits jumped out from almost under the wheels, where they had been lying flat on the ground with necks outstretched.

'Herd after herd of wild asses pounded along beside us, unable to tear themselves away from the fascination of the car. Most of the asses were mares and many of them were chaperoning fuzzy, long-legged colts. It was amusing to see the little fellows bend to the work of keeping up with their mothers. With ears laid back and slim legs flying they put every ounce of strength and determination into what probably was the first time in their short lives that they had run from danger. Once we saw four wild asses fighting. Kicking and biting viciously, they kept at it until the car approached and they joined the zoological assemblage which we were driving up the dry lake-bed.

'In spite of the thousands of animals, there was something utterly desolate about the valley. Perhaps it was the black mountain walls which shut us in and the fact that for more than a hundred miles we had not seen even the remains of an old camp-fire or the circular mark left by a Mongol tent. All of us were exhausted when we camped at dark in a sandy stream-bed. The speedometer of the car registered one hundred and fifty miles . . .' (pp. 219-220.)

Wild Camels in the Black Gobi

'Three of the men said that they had seen wild camels in the Black Gobi but only at a distance. They were very shy and almost like mythical creatures. Some Mongols, they said, had caught them when young but that even then they were difficult to tame. As far as I can discover, very little has been published about wild camels. Doubtless this is due to the fact that few explorers have visited the arid Black Gobi where they live.' (p. 296.)

Argali shot from an Automobile

'While we were returning through a mountain pass just before dark, two great brown animals leaped into view on the saw-tooth rim of the highest peak. Lovell saw them first. 'Sheep, as I'm alive!' he shouted. There they stood, two magnificent rams, silhouetted against the sunset sky. Granger's rifle was in the car beside me. As Lovell switched off the power, I fired, sending my bullet into the quarters of the larger ram. I wonder if any other man has ever shot a mountain sheep from a motor car! I have killed a good many bighorns but never one that did not exact strenuous work. Sheep-hunting means hard climbing, skilful stalking, straight shooting. To sit comfortably in a touring car and pot a Mongolian argali, the trophy *par excellence* of a sportsman's life, was a new experience. Incidentally, it gives an idea of where we had taken that car about as plainly as it could be told. I am not surprised that the sheep were too curious to run away when the roaring black thing appeared among their mountain peaks. Our being there seemed so strange even to us that at times we could hardly believe it true.' (p. 305)

Photographing a Great Herd of Antelope

'. . . This time they had arranged themselves as though directed by a stage manager; perhaps fifty thousand were in the bottom of an enormous valley where from the rim we could "shoot" down at them with the telephoto lens. There was a light wind and for the first time in my life I could *smell* live antelope. A mile away the squalling of the babies could be heard. With the glasses we could see them nursing and playing. All the intimate details of domestic antelope life were carried on before our eyes. Sometimes a thousand or so would dash at full speed through the center of the herd, only to stop abruptly and begin to feed. The mass was in constant motion; hardly for a moment as any part of it stationary, although the animals were entirely at peace.' (p. 317.)

'A magnificent herd of gazelles, *Procapra gutturosa,* suddenly appeared in front of us. There must have been at least twenty-five thousand bucks, does and fawns, running on all sides of the cars.' (p. 407)

The Fish of the Tsangan Nor Region:

'During the night of our return to camp a strange thing happened. We were awakened by fish! A strong wind blew from the west until about two o'clock in the morning, pushing the water in the shallow lake over to our side. Suddenly the wind dropped and the water receded so quickly that thousands of small fish which had been feeding close up under the bank were left stranded on a strip of mud about three feet wide. Flapping widely as they tried to work back into the water, they made a noise like scores of people softly clapping their hands.' (p. 298)

Experimental spirit in a Bird

One day . . . one of the youngster Great Tits made an important discovery . . . In the west room there hangs a large plastic lamp shade, shrouded in dark chiffon. . . . The Tit flew to this shade, inspected it carefully, then bored a small hole through the chiffon and tapped on the broad rim underneath. Discovering the noise this made, she excitedly pulled and tore at the chiffon . . . This done she rained blows on the taut plastic band with the vigour of a Nuthatch, putting her back into it and at times nearly losing her grip of the slippery foothold, but she went on rapping, louder and louder, making such resounding bangs that it brought several Tits hurrying through the fanlight to see what she was doing, one of them so scared by the sound that she quickly retreated again. The others stared a moment, then a male (adult) flew to the shade and chased her off, afterwards perching there himself to make an examination before flying away. The discoverer then returned to continue her drum music. Drummer as I named her, now began experimenting on different parts of the shade, tearing many small holes in the chiffon, then testing the sounds with sharp raps on various parts of the shade. Except on the broad rim (or band) the sound was feeble and low-toned, for only the rim was tightly stretched. She went back to it in between testing other parts, evidently to compare the sounds. She did this with quick, excited movements, obviously thrilled by her discovery. The broad rim was then tested on the other side of the shade, the noise there being the same; she then made hammering tests on one or two other things in the room which produced little noise, but she stayed several moments on the screen, hammering for all she was worth. The noise it made was nothing compared to the shade, so she returned to this for another ten minutes of drum music before she flew away. Drummer often repeated a short performance (always on the rim) during the autumn, but in these later performances the excitement of discovery was missing.

(LIVING WITH BIRDS by Len Howard, 1956, page 56)

Hormone Treatment increases Wool Growth

Experiments on a cheap and simple way of increasing wool yields have been in progress at the Lincoln College, Canterbury, New Zealand. These involve the administration of the hormone 'L'-thyroxine' to sheep, and the limited samples on which this was carried out successfully during the last three years has given very encouraging results with no visible ill-effects on the animals subjected to the experiments nor any reduction in lambing percentages. In the treated animals the wool was of a definitely finer quality and the growth was found to have increased by an average of 13.5% (about one lb. on an 8 lb. fleece).

The *World* Wool Digest reports that 'the hormone treatment resulted from the discovery that changes in the alternation of light and darkness produced a spurt in wool growth. This effect was traced back to the light-sensitive pituitary gland, the "master" gland which controls most of the body's hormones. Researchers found a definite rhythm which gave the best growth. This was the alternation of eight hours' light and 16 hours' darkness. From their indoor, artificial light experiments this group yielded 15 per cent more wool than a control flock exposed to a duplication of the normal, seasonally-varying amounts of light. The link between light, the pituitary and wool growth explains why wool growth varies throughout the year in response to the changing pattern of daylight and darkness'.

Further experiments on a large scale are in progress, the results of which shall be looked forward to with interest.

[*World* Wool Digest, VII (25) : 269, 5th December, 1956]

Education of Children

'What beautiful and useful knowledge the teaching of Natural History might put into childish heads, if only science would consider the very young; if our barracks of universities would only combine the lifeless study of books with the living study of the fields; if only the red tape of the curriculum, so dear to bureaucrats, would not strangle all initiative.

Little Paul [his seven-year old son] and I will study as much as possible in the open country, among the rosemary bushes and the arbutus. There we shall gain vigour of body and of mind; we shall find the true and beautiful better than in school books.' (J. H. Fabre in 'SOCIAL LIFE IN THE INSECT WORLD'.)

Life Span of the Common Shrew, Sorex araneus L.

It has been believed that the entire wild population of shrews in England was completely renewed each year and that no individual survived longer than two summers and the intervening winter. Mr. Peter Crowcroft of the Bureau of Animal Population, Department of Zoological Field Studies, Oxford University, undertook an examination of this statement on the basis of teeth wear and confirms that the common shrew does not breed in the year of birth, and dies before the end of the following year. Individuals caught during winter were neither sexually mature, nor had they teeth as worn as those of mature animals.

[*Proc. Zool. Soc., London,* 127 (2): 285-292, October, 1956]

Honey in Australian Ants

'The honey-ant (*Melophorus inflatus*) is found in many parts of central Australia, where it is highly regarded by the aborigines as an article of food. The honey-bearing ants seem to be modified workers which are fed with nectar or honey by ordinary workers until their distended abdomens approach $\frac{3}{8}$ in. in diameter. "In eating them the native seizes each with the fingers by the forepart of the body and, after blowing off the dust, places the distended abdomen of the insect in the mouth and bites it off, letting the slightly acid honey flow over the tongue with evident satisfaction. The abdomen is swallowed while the remainder of the body is discarded".'

[G. M. Badger and W. Korytnyk, University of Adelaide, S. Australia, in *Nature,* 178: 320-321, August 11, 1956]

NOTES AND NEWS

It is gratifying to note that the Indian Forest Service is also beginning to agree that the existing machinery for the preservation of wild life is insufficient and that a more specialized staff both inside and outside forests is neccessary. Item IV. (1) of the Recommendations of the IX Silvicultural Conference held in December 1956 at Dehra Dun reads:

"WHEREAS

(*a*) the condition of the wild life of the country, particularly in the areas outside legally constituted forests, has been steadily going from bad to worse;

(*b*) the existing machinery is inadequate to cope with the enforcement of the provisions of wild life legislation, which in many States is inadequate and defective;

(*c*) the concept of wild life as an integral part of the forest complex deserving of greater attention and the concept of wild life as a forest crop, has not yet found sufficient place in forest management;

(*d*) the existing methods of conservation and control, which are the two aspects of wild life management, are not based on sound scientific principles of an ecological nature nor on adequate censuses and surveys, but on casual observations and impressions resulting in faulty management practices of an empirical nature.

THIS CONFERENCE RECOMMENDS THAT

(1) urgent attention be paid to the problems of protection of wild life both within the constituted forests and outside them;

(2) special staff be set aside in every State for the exclusive task of protecting and conserving stocks of wild life and for controlling harmful species and vermin, both within and without constituted forests;

(3) forest working plans devote more attention to the problems of management of wild life as an integral part of the forest complex and as a forest crop; and

(4) research be undertaken on the ecology of wild life species and proper censuses and surveys, which form the basis of all wild life measures.' [*The Indian Forester,* 83 (3): 215, March 1957.]

* * * *

We have received from the Promotion Section, Distribution Division, Documents and Publication Service, United Nations Educational, Scientific and Cultural Organization, descriptive leaflets of their recent publication entitled 'Study Abroad VIII-1956/1957' which contains information on over 74,000 awards offered in 1956/1957. The book is priced $2.00 or 10*s*. 6*d*., and may be obtained from Orient Longmans Ltd., Indian Mercantile Chamber, Nicol Road, Bombay; 17 Chittaranjan Ave., Calcutta; 36-A Mount Road, Madras; Sub-depots Oxford Book and Stationery Co., Scindia House, New Delhi; Rajkamal Publications Ltd., Himalaya House, Hornby Road, Bombay 1.

CORRECTION

In the Note on 'The Dimorphic Egrets', Vol. 54 (1), p. 189, para 4, line 1.

For 'generic' *read* 'genetic'.

REGISTRATION OF NEWSPAPERS (CENTRAL) RULES 1956

Statement about ownership and other particulars about the

JOURNAL OF THE BOMBAY NATURAL HISTORY SOCIETY

to be published in the first issue every year after the last day of February

FORM IV

(See Rule 8)

1. *Place of publication.*—The Diocesan Press, Vepery, Madras 7.
2. *Periodicity of its publication.*—Three times a year. April/August/December.
3. *Printer's Name.*—V. M. Philip.
   Nationality.—Indian.
   Address.—Diocesan Press, Post Box 455, Vepery, Madras 7.
4. *Publisher's Name.*—V. M. Philip.
   Nationality.—Indian.
   Address.—Diocesan Press, Post Box 455, Vepery, Madras 7.
5. *Editor's Name.*—(1) Sálim Ali, (2) Rev. Fr. H. Santapau, S.J.,
   Nationality.—(1) Indian. (2) Indian.
   Address.—Bombay Natural History Society, 114, Apollo Street, Fort, Bombay 1.

6. *Names and addresses of individuals who own the Newspaper and partners or shareholders holding more than one per cent of the total capital.*—Bombay Natural History Society.

I, V. M. Philip, hereby declare that the particulars given above are true to the best of my knowledge and belief.

(Sd.) V. M. Philip,
Signature of Publisher.

Date: 20-4-1957.

PRINTED AND PUBLISHED BY V. M. PHILIP AT THE DIOCESAN PRESS
18 CHURCH ROAD, VEPERY, MADRAS—3-6-1957. C7220
EDITORS: SALIM ALI, AND H. SANTAPAU
114 APOLLO STREET, FORT, BOMBAY

NOTICE TO CONTRIBUTORS

Contributors of scientific articles are requested to assist the editors by observing the following instructions:

1. Papers which have at the same time been offered for publication to other journals or periodicals, or have already been published elsewhere, should not be submitted.

2. The MS should preferably be typed (double spacing) on one side of a sheet only, and the sheets properly numbered.

3. All scientific names, to be printed in italics, should be underlined. Both in zoological and in botanical references only the initial letter of the genus is capitalized. The specific and sub-specific names always begin with a small letter even if they refer to a person or a place, e.g., *Anthus hodgsoni hodgsoni* or *Streptopelia chinensis suratensis* or *Dimeria blatteri*.

4. Trinomials referring to subspecies should only be used where identification has been authentically established by comparison of specimens actually collected. In all other cases, or where identification is based merely on sight, binomials should be used.

5. Photographs for reproduction must be clear and show good contrast. Prints must be of a size not smaller than 3¼ × 2¼ inches (No. 2 Brownie) and on glossy glazed paper.

6. Text figures, line drawings and maps should be in Indian ink, preferably on Bristol board.

7. References to literature should be placed at the end of the paper, alphabetically arranged under author's name with the abridged titles of journals or periodicals underlined (italics), and titles of books *not* underlined (roman type), thus:

Roepke, W. (1949): The Genus Nyctemera Hübner. *Trans. ent. Soc. Lond.*, **100** (2): 47-70.

Prater, S. H. (1948): The Book of Indian Animals, Bombay.

Titles of papers should not be underlined.

8. Reference to literature in the text should be made by quoting the author's name and year of publication, thus: (Roepke, 1949).

9. *Synopsis*: As recommended by the Royal Society Scientific Information Conference (July 1948), the editors consider it desirable that each scientific paper be accompanied by a synopsis appearing at the beginning, immediately after the title. The synopsis should be factual. It should convey briefly the content of the paper; draw attention to all new information and to the author's main conclusions. It should also indicate newly observed facts, the method and conclusions of an experiment, and if possible the essential points of any new finding, theory or technique. It should be concise and normally not exceed 200 words.

When the synopsis is completed it should be carefully revised by the author to clarify obscurities, and further compressed wherever possible without detracting from its usefulness.

114 Apollo Street, Fort,
Bombay 1

EDITORS,
JOURNAL OF THE BOMBAY NATURAL HISTORY SOCIETY

THE SOCIETY'S PUBLICATIONS

Mammals

The Book of Indian Animals, by S. H. Prater. With many coloured and black and white plates. 2nd (revised) edition. (*In preparation*)

Birds

Game Birds of India, by E. C. Stuart Baker. Vol. III. Pheasants, 1st Edition. **Rs. 20**
(*Price to Members Rs.* 15)

The Book of Indian Birds, by Sálim Ali. With 56 coloured and 22 black and white plates, 5th (new) edition, revised and enlarged. **Rs. 20**
(*Price to Members Rs.* 16)

Fish

Circumventing the Mahseer and Other Sporting Fish in India and Burma, by A. St. J. Macdonald. With coloured and black and white plates. **Rs. 15**
(*Price to Members Rs.* 12)

Miscellaneous

Some Beautiful Indian Trees, by Blatter and Millard. With many coloured and monochrome plates. 2nd (revised) edition. **Rs. 20**
(*Price to Members Rs.* 16)

Some Beautiful Indian Climbers and Shrubs, by Bor and Raizada. With many coloured and monochrome plates. **Rs. 22**
(*Price to Members Rs.* 17·50)

Butterflies of the Indian Region, by M. A. Wynter-Blyth. With 27 coloured and 45 monochrome plates. **Rs. 28**
(*Price to Members Rs.* 22·50)

Indian Molluscs, by James Hornell. With 2 coloured and many monochrome plates, and text figures. **Rs. 6**
(*Price to Members Rs.* 4·50)

Glimpses of Nature Series Booklets :

OUR BIRDS, 1 (with 8 coloured plates) in English, Gujarati, Hindi, Kannada and Marathi.	**62 nP**
OUR BIRDS, 2 (with 8 coloured plates) in English. (Editions in provincial languages in preparation)	**62 nP**
OUR BEAUTIFUL TREES, 3 (with 8 coloured plates) English (Editions in provincial languages in preparation)	**62 nP**

Wall Chart to distinguish a Wild Dog from a Domestic Dog or Jackal. etc. **Rs. 2.50**

Identification of Poisonous Snakes—Wall charts in English, Gujarati and Mahratti. (*In preparation*)

Back numbers of the Society's Journal. Rates on application.

Obtainable from :

The Honorary Secretary,
Bombay Natural History Society,
114 Apollo Street, Bombay 1.

London Agents :

Messrs. Wheldon & Wesley Ltd.,
83/84 Berwick Street,
London, W. 1.

TERMS OF MEMBERSHIP

Life Members pay an entrance fee of Rs. 25 and a life membership fee of Rs. 500.

Ordinary Members pay an entrance fee of Rs. 25 and an annual subscription of Rs. 30.

The subscription of members elected in October, November and December covers the period from the date of their election up till the end of the following year.

MEMBERS RESIDING OUTSIDE INDIA

The terms are the same for members living outside India. Such members should pay their subscriptions by means of orders on their Bankers to pay the amount of the subscription, plus postage—in all Rs. 32.12—to the Society in Bombay on the 1st January in each year. If this cannot be done, then the sum of £2-8-0 should be paid annually to the Society's London Bankers—The National Bank of India, Bishopsgate Street, London, E.C.

The Heckman Bindery, Inc.
N. Manchester, Ind.
MAY 1961
Bound To Please

SMITHSONIAN INSTITUTION LIBRARIES
3 9088 01205 0910